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TRANSPORTATION RESEARCH NEEDS RELATED TO SOCIAL, ECONOMIC, AND ENVIRONMENTAL ISSUES

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Report of a Workshop on Research Needs held July 25-27, 1977, by the Social, Economic and Environmental Section of the Transportation Research Board

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Introduction

An important function of Transportation Research Board committees is to identify research needs in the subject area of the committee. Most committees do this on a continuing basis. To emphasize this activity, the committees in the Social, Economic, and Environmental Section conducted a Workshop on Research Needs at Morgantown, West Virginia, on July 27, 28, 29, 1977. This circular results from that workshop.

The first part of the circular consists of research problem statements. These are intended to help provide guidance to government agencies, research institutions, industry, universities, and others in allocating funds and manpower to solve transportation problems. The statements do not and are not intended to constitute a research program. Instead they are intended to help those seeking ideas, guidance, confirmation, or clarification in transportation research.

The problem statements are arranged by major subject area of committees in the Social, Economic, and Environmental Section. Within subject areas, statements are noted as priority and other. The priority was established at the workshop and by a review of committee chairmen, the section chairman, and staff of the board.

Only about half of the statements from the workshop are included in this circular. Most of the others were transferred to other sections for consideration. Some statements were dropped, primarily because there is work underway on the problem. While efforts were made to consider all pertinent activity related to each problem, it is likely that some current research was overlooked which would have altered the retention of certain problem statements or the recommended priority.

The second part of the circular contains the remarks of the invited speakers dealing with research needs. The remarks of the speakers and of the session moderators not only helped generate research problem statements but have stimulated other activity (such as a conference session on serving carrier and shipper needs).

Finally, the circular includes an index and a list of participants. The index is to help readers locate topics of particular interest in the problem statements or in speakers' remarks.

Research Problem Statements

An asterisk by the statements below indicates those that the workshop and a later review found to be priority research needs.

CITIZENSHIP PARTICIPATION

*Citizen Participation in Nonmajor Actions

Problem

Federal rule making has established a definition for a "major federal action significantly affecting the environment." A negative declaration that a project is not major means that the action contemplated does not require the preparation of an environmental impact statement (EIS). Consequently, it is exempt from the procedural and administrative scrutiny which is associated with the preparation of such a statement. Apparently the process of EIS preparation has frequently afforded interest groups an important and useful way of helping shape proposals for public investments in transportation, even if such participation means "no build." Consequently, much greater reliance is placed on local political processes for accommodation of citizen participation. As more emphasis is placed on maintenance and TSM projects, there is a concern that these activities will be classified as "nonmajor actions," thereby reducing the potential avenues for surfacing and discussing critical issues related to these actions. It also diminishes the possible procedural and legal remedies available to citizens who seek to influcence local decision making.

Proposal

Determine whether research has been specifically directed toward the issue of citizen participation in nonmajor actions. Analyze general nonmajor actions and make recommendations concerning the place in the planning process for citizen participation.

*Citizen Participation in Energy-Efficiency Improvements

Problem

There is poor public understanding of the extent and severity of the energy crisis generally, of the role of transportation in it, and of how the public's transportation usage patterns contribute to it. In addition, there is public resistance to changing behavior patterns and considering consumption alternatives and constraints. At the same time, we face an immediate need to find and implement programs for more efficient use of energy in transportation. Public understanding, involvement, and support is necessary if more efficient energy allocation programs are to be politically acceptable and practically workable. Therefore, the purpose of this research is to identify ways to gain such public understanding, involve citizens in energy allocation plans and decisions, and increase public support for efficiency improvement programs.

Proposal

Research will draw on past experiences with citizen participation in other aspects of transportation planning in order to identify ways to increase

public understanding, involvement, and support of energy efficiency improvements in transportation. Particular attention will be given to approaches which have proven helpful in educating the public about the nature and severity of transportation problems, gaining public exposure and debate of alternative solutions and their pros and cons, educating decision makers about public preferences and politically acceptable solutions, and increasing public influence on and acceptance of decisions that result. Research also will draw on relevant experiences in other subject areas (such as 208 water quality planning), as well as on information from the political and behavioral sciences and communications. The research will formulate strategies for increasing public understanding and gaining public participation in making energy efficiency improvements.

Intergovernmental Responsibilities for Citizen Participation

Problem

All levels of government are involved with citizen participation at some stage in the transportation planning process. Examination of these involvements is necessary in order to reduce agency and citizen confusion and redundancy. The appropriate roles and responsibilities of governmental bodies at the federal, state, regional, and local levels require clarification and improved coordination. This must be done within the context of the authorities and responsibilities of the governmental bodies at each level.

Proposal

Particular topics to be examined include: instances where responsibility for citizen participation is shared and/or shifts over time between governmental bodies at different levels; issues of compatability and consistency among agencies' overall citizen participation strategies and requirements; instances of shared responsibility among agencies, with special attention given to the designation of lead agencies, more efficient ways for agency interaction, and better intergovernmental communications mechanisms; identification of opportunities for improving efficiency and clarifying responsibilities.

ECONOMIC AND SOCIAL

*Opportunity Costs of Providing Urban Parking

Problem

Much space in downtowns of cities has been preempted to accommodate on-street and off-street parking of autos. Both on and off-street parking contribute to congestion and discourage attempts to revitalize downtown urban areas for pedestrian and residential uses. Off-street parking precludes land uses that could significantly contribute to environmental, aesthetic, social, and economic improvement. A strong need exists to systematically examine the true opportunity costs of using downtown lands, both public and private, for parking so that regulatory and pricing policies can be formulated.

Proposal

Auto restricted zones (ARZ) have been and are being implemented in a number of U. S. and foreign cities.

1. Select some of these for case studies.
2. Estimate total direct and indirect returns to land formerly and now in alternative uses.
3. Develop information as to the alternative transport modes and vehicle occupancy rates that accompanied the change and about the shift of parking to peripheral or other areas.

*Effectiveness of Economic, Social, and Environmental Procedures

Problem

In recent years, there have been many new transportation laws, rules, and regulations primarily concerned with social and environmental aspects. Complying with these has added to the cost and time of completing highway or other transportation projects. In some cases, projects have been completed that are substantially the same as the projects that were proposed initially but the costs of delays through higher construction costs, fatalities, or other user losses on old facilities may be substantial. In other cases, projects have been modified or abandoned. There is a need to determine the magnitude of the costs of delays, modifications, or abandonments.

Proposal

Identify aspects of environmental review and the participatory process which can be compressed without compromising the intent of these efforts. Examine federal statutes and regulations relating to social, economic, and environmental factors regarding public works to determine how the environment can be protected and yet insure that necessary facilities are constructed in a timely manner and based on adequate information on impacts. Identify and analyze instances where environmental and process requirements are effectively accomplishing their intent and cases where they impose unnecessary costs and delays.

*Urban Neighborhoods---Definition and Transportation Impacts

Problem

Transportation has both positive and negative effects on urban neighborhoods, especially with regard to the quality of life. This is especially evident in the many instances where proposed transportation changes have been strongly supported by some interests and as strongly opposed by others. There is a need for a methodology and for measurements to determine these impacts.

Proposal

Develop the concept of an urban neighborhood in terms of measurable characteristics such as cohesion indicators and the quality of life as it may be affected by changes in the transportation system. Develop the methodology for using this neighborhood concept for evaluating the impact of a proposed transportation change on an affected neighborhood.

Impact of Low-Cost Urban Highway Improvements

Problem

The emphasis of current Transportation Improvement Program and Transport Systems Management is shifting to "Low-Cost Urban Highway Improvement"(such as road widening). Although these improvements are not

considered "major actions," citizens are objecting to their negative effects, and in some cases, holding up projects. The effects of these low-cost improvements and how to deal with them in project planning need to be known.

Proposal

Conduct before and after studies to associate impacts with types of improvements and to analyze the significance of these effects. The scope of the study could vary, depending on the types of improvements and impacts studied.

Impact of Postponing or Staging Transportation Projects

Problem

Because of limited funds, additional statutory requirements, and conflicting values, the construction of new highways has been postponed or staged over a longer period of time. At the same time, automobile traffic has continued to increase on the existing facilities, resulting in congestion in urban areas. Such actions have direct effects on highway users and indirect effects on the community (nonusers). The extent of these impacts needs to be documented.

Proposal

Analyze case studies of a selected number of urban highway projects which have been postponed or staged to determine the direct and indirect effects of such actions. Comparisons can be made with control projects which were not postponed or staged to help identify and quantify these effects.

Impact of State-Subsidized Rail Passenger Service

Problem

Since Amtrak began operations, a number of states have initiated subsidized (Section 403B) services. Such services were begun with the belief that they would produce a number of benefits for the traveling public, and would have desirable secondary economic, environmental, and social effects. More recently, there have been complaints that state subsidized services are costly, are used only or mainly by well-to-do members of the public, and have driven competing transport modes out of business (as witness recent bus company testimony before the ICC regarding Michigan's subsidized services). There is little factual evidence available to support one side or the other on this issue. There is need for research concerning the direct and indirect impacts of state supported services in order to guide other states that may be considering setting up similar rail passenger routes.

Proposal

Survey riders of subsidized services to determine who they are, why they make their trips, and what are their alternatives. Preferably this study would be done over time, from the point of initiation of a route. Simultaneously, competing air and bus modes should be surveyed. Good cost information should be obtained and financial impacts upon firms should be measured. Estimates should be made of the environmental consequences of shifting passengers from one mode to the other and for any passenger travel that is generated.

Marginal Costs in Transit Service

Problem

Empirical evaluations of the net marginal social cost of transit service are in a very rudimentary state. Knowledge of the behavior of marginal cost is essential for design of efficient systems of user charges.

Proposal

Estimate marginal cost patterns for various forms of urban transit in typical situations, including allowances for delay at stops, effects on passenger waiting and travel time, and traffic externalities.

ENGINEERING ECONOMIC ANALYSIS

*Usage, Methods, Factors, and Applications of Comprehensive Economic Analysis

Problem

Because unit costs of construction and maintenance as well as modal competition for funds are increasing, it is becoming more and more important that transportation investment decisions consider the economic consequences. For example, economic analysis should be widely used by state DOT's—the principles of engineering economy are well known and many of the necessary input factors are available, although oftentimes in different degrees of refinement. However, in transportation, the application of economic analysis has just scratched the surface (see Roddin/Anderson, TRB Record No. 550).

Proposal

This phase shall be a 15-20 state in-depth review of the current practice of economic analysis by state departments of highways and/or transportation including, where feasible, MPO's and regional transportation authorities. The review should include:

1. Degree to which economic analysis techniques are used and, when used, the methods of analysis and factor inputs employed;
2. When economic analysis is not used, an analysis of the reasons and of the decision mechanisms used to allocate funds;
3. Survey of existing computer programs at state/federal/university levels employed either as data storage/retrieval systems or for analytical purposes;
4. Survey of prior research in resource allocation (funded or not funded) which may be useful but currently may not be used;
5. Identification of consistencies and problems in across-mode analyses. The purposes of this review are to help present and potential users determine the most effective or desirable analytical methods and to demonstrate the wide applicability of economic analysis.

Examples of potential applications will be developed in areas such as analysis of costs of deferred maintenance, transit, bridge versus ferry decisions, and toll versus nontoll facilities.

*Transportation Investment Evaluative Models for Comprehensive Economic Analysis

Problem

A major problem for highway and regional transportation planners at all levels of government is that of meeting growing transportation network needs within the constraints of limited annual budgets. A number of approaches to solving this problem are emerging. Prominent among these are the new revision of the "Redbook" (Stanford Research Institute), the Highway Investment and Analysis Package (HIAP, Multisystems, Inc., Cambridge, Massachusetts), and "Resource Constrained Capital Budgeting Model for State and Highway Rehabilitation and Maintenance, " (Texas A & M). There are a number of incompatibilities among these decision tools that need to be investigated and evaluated if any particular approach is to be supported over another approach. Further, the routine application of economic analysis is hampered by the inordinate amount of time required for economic analysis of hundreds of proposed transportation investments, many having several alternatives. This is Phase II of a 2-phase study.

Proposal

This phase will develop a system of interrelated models for the comprehensive economic analysis of proposed transportation investments. The work will integrate previous and ongoing studies and operating computer programs to provide a wide range of analytical capability from system analyses to project design alternatives analyses, multimodal analyses, low-capital intensive versus high-capital intensive alternatives, resource allocation, etc. The research will include:

1. Investigate and compare the decision-making mechanisms expressed in or implied by the procedure and techniques employed in the aforementioned and related models such as those in the UMTA and FHWA software packages.
2. Investigate and report on the efficiency of these and related mathematical programming techniques.
3. Investigate and report on the ability of these techniques to arrive at optimum, or near optimum, project sequencing and maintenance planning schedules over various planning horizons.

*System Performance and Life-Cycle Cost

Problem

Past transportation planning has focused on provision of new facilities, in large measure because it was in the national interest to encourage system growth. Also, perhaps partly as a result of federal grants or tax provisions, there is a first-cost bias in purchasing decisions, including decisions on transportation equipment. In some instances, both individuals and firms pay more attention than economic rationality would suggest to initial capital costs and less attention to subsequent operating and maintenance costs. New system growth may now be less desirable since resources for transportation are more limited. There is a need to understand the tradeoffs between design and operations and maintenance in determining cost among standards, user benefits and costs---and among transport sector costs, "external" impacts,and transport service.

Proposal

Explore relationships between original and operating costs and develop management guidelines and recommendations for federal and state policy on transportation funding. Integrate previous and ongoing studies to accomplish the following tasks:

1. Define system performance in a manner compatible with economic analysis of investment strategies.
2. Relate initial design/construction standards and costs to maintenance policy and costs, so as to maintain constant levels of system performance.
3. Extend these relationships to permit life cycle costing of the transportation facility.
4. Show how performance levels and life cycle costs may be traded off. Highways, at a statewide level, might be a most promising case.

Transportation Costs of Substandard Highways

Problem

It is taken as an article of faith that roads and highways must be maintained to some degree of structural and operational performance standard in order to serve the public. Yet the proportions of the problem engendered by driving on substandard roads have never been clearly defined.

It is presumed, for example, that a structurally or operationally deficient road imposes a penalty on the user in terms of inconvenience, discomfort, additional travel time, higher running costs, and possibly increased accident costs; at present, however, the magnitude of that penalty can be merely guessed at or perhaps be indirectly estimated.

So long as the costs of driving substandard roads remains unknown, it is impossible to determine reliably the level of maintenance/improvement/reconstruction investment that is economically justified to sustain highways in adequate condition.

Proposal

Conduct an investigation to determine the excess operating costs incurred by vehicles operating on substandard highways. The general objectives of this investigation would be:

1. To establish the criteria that characterize a highway or system of highways as "substandard." These criteria would be associated with the structural condition of the road surface, the soundness of the roadway design elements and geometry, and the operational efficiency of the traffic flow along the road.
2. To determine the excess user costs associated with driving on substandard roads. The costs to be considered would include running expenses (fuel, lubricants, tires, vehicle repair, and the like), cost of time loss, excess cost of accidents attributable to roadway deficiencies, penalty costs associated with discomfort and inconvenience, and increased depreciation.

Economic Evaluation of Deferred Highway Maintenance

Problem

In order to maintain an adequate service level roadway surfaces must periodically be overlayed or otherwise receive major repair or reconstruction. As a

road surface deteriorates normal maintenance becomes more and more expensive until major repair or reconstruction takes place. Benefits to road users decline during the period of deterioration. In addition, the cost of reconstruction or major repair, usually an overlay, increases as the road surface deteriorates. From the point of view of economic efficiency, when is the most desirable time to provide an overlay or other form of reconstruction?

Proposal

Most states collect data on maintenance costs which can be related to particular highway sections and of vehicle operation costs which may be related to the condition of roadways. Over the past 7 years, Oregon, and perhaps several other states, has developed surface condition ratings for state highways, by section. Finally, the costs of returning surface conditions to a specified level from different degrees of deterioration may be calculated for particular highway sections. By relating these data to general equations of the AASHO road test results and other engineering studies, it should be possible to determine the most cost effective point at which to overlay a particular section of highway.

Economic Cost of Traffic Accidents

Problem

The cost of traffic accidents has long been a factor in cost-benefit analyses (economic analysis) of proposed highway investments and in planning and programing studies. The dollar costs available, however, have been compiled on the basis of concepts and procedures that have neglected the economic concepts, principles, and procedures of cost-benefit analysis. With special reference to permanent disability and death, there is a wide range of dollar values available, some determined on the basis of personal values, some on humanitarian values, and yet none on strictly economic dollars as related to the conservation of resources. Traffic accident dollars should be of the same concept and base as are highway construction dollars and vehicle running cost dollars. The last accident cost compilation was made in 1966 for the Washington, D. C., area and is now too old to update even if the costs had been compiled on the correct economic basis. There is need to distinguish social and human values from economic cost dollars.

Proposal

Compile tables of actual economic costs now being experienced with highway traffic accidents on the basis of conservation of resources and for specific use in economic analyses to determine the relative transportation economy of proposed investments in highway facilities. The overall research is divided into two phases. Phase 1 is the conceptual and planning phase and Phase 2 is the collection, analysis, and assembly of the economic costs.

In Phase 1, included are such tasks as:

1. Isolate and define each cost item that could possibly be involved, divided into main and submain items.
2. Determine the viewpoint from which each cost item is to be costed.
3. Determine the procedure and subfactors associated with each cost item.
4. List each main and submain item for which dollar costs are to be collected through field investigations of actual accidents and records.
5. Determine the general approach to be used in the field study with reference to geographical areas, highway systems, cooperating agencies (highway departments), accident record year to be studied, and duration of the research.
6. Determine what costs, if any, should be collected for application to any use that would require costs on a different basis than for cost-benefit analysis of proposed highway investment improvements.

Include in the study both officially reported accidents and nonreported accidents. Final costs to be reported on both a cost per accident basis and cost per vehicle involvement.

Phase 1 should conclude whether accident rates based on vehicle miles or traffic volumes should be collected.

Phase 2 is the actual field collection of accident cost information (and accident rates, if desirable). The concepts and procedures arrived at in Phase 1 are to be followed. Phase 2 will give attention in its planning stage of such items as: sampling procedure, methods of collecting and checking cost data, field and headquarters organization, data reduction and analysis procedures, and any other special problems.

The final report should be so arranged that the results can be updated with minimum effort and maximum reliability. Further, the final costs should be capable of being adjusted for geographical differences as well as for highway systems and characteristics of traffic and types of vehicles.

FREIGHT MOVEMENT

*Disaggregate Modal-Split Models for Freight

Problem

Little is known about the decision mechanisms by which firms determine their modes of shipping (shippers/receivers). To what extent is the physical distribution concept of freight demand followed (i.e., a vector of service characteristics) or to what extent are firms minimizing their expenditure on transportation costs (rates)? To what extent are they concerned with other factors such as customer satisfaction, speed and reliability of delivery, and to what extent are decisions based on fact at all. Can shipper decision rules be quantified so that demand projection can be made and so that policy questions can be answered, e.g., user taxes, investment of infra-structure questions?

Proposal

Survey firms (potentially in conjunction with the census of transportation) to determine modal decision rules. Collect shipment data by individual shipment with characteristics of the shipment and characteristics of the chosen and nonchosen models (time in transit, reliability, loss and damage, rate, etc.,will be required). Analyze the data to develop disaggregate modal split models (like the urban transportation models). Develop aggregate models from the disaggregate data by commodity and by region (if necessary). Compare the aggregate and disaggregate models.

*Institutional Problems in Providing Transportation Data

Problem

Data needs in the transportation field are diverse and seemingly insatiable. Developing data bases of good quality is expensive. Data needed for national policy making, program planning, and research in the transportation area is often lacking or inadequate because of extreme fragmentation and/or overlapping jurisdictional responsibilities of many governmental agencies. This leads to duplication and inefficiencies in the information system.

Proposal

Study the federal statistical system with respect to transportation related data currently collected to determine which agencies are collecting data in the freight (goods) movement area. Evaluate the potential for coordinating or combining agency collection programs for data of similar kind. This is particularly true of those agencies which began collecting and assembling data to gain insight into their own activities or to fulfill regulatory or operating missions. The interagency interchange of data, the restructuring of the statistical system and other operational recommendations aimed at reducing fragmentation, consolidating funding, and redefining responsibilities for collection and maintenance of transportation information would be dealt with. Management of and access to the data also will be studied.

*Data and Analysis Systems for All Modes Moving Intercity Freight

Problem

Many federal agencies collect various types of transportation data for many purposes. The data are not comparable by mode, geographical coverage, time periods, commodity description, or financial definition. Intermodal flows would be included.

Proposal

Review existing transportation data, collection systems and design necessary supplemental or new data collection systems for the following: (1) commodity flow data, (2) cost and capacity characteristics, (3) financial statements, (4) energy utilization, (5) accident data on comparable bases, (6) social measurement information, (7) environmental data for all transportation modes.

Problems of the proprietary nature of data will be investigated. A pretest would be made of the proposed system.

Characteristics of Transport Service to Small, Remote Shippers

Problem

One of the least understood, but politically most volatile, aspects of regulatory change affecting freight transport concerns the plight of shippers in "remote" areas (anywhere outside the heavy freight corridors) particularly "small" shippers (i.e., firms too small to consider private transport). It often is argued that existing regulations effectively cross-subsidize transport service for such shippers, and that certain shifts in regulatory policy could dramatically increase the cost of service to these shippers, often threatening their economic livelihood.

Proposal

Survey current costs, alternatives, and service levels of small, remote shippers. The survey should focus both on current service, currently available alternatives, and hypothetical alternatives which might emerge under regulatory changes. Analysis should attempt to quantify the range of shipper needs and the proportions of them likely to shift transport, relocate, close, etc., under various types of regulatory policy change.

INTERMODAL FREIGHT

*Improved Human Resource Use in Intermodal Freight Operations

Problem

Labor constitutes between 35 to 45 percent of the total unit costs for present rail/truck intermodal operations. Management must accept responsibility for certain inefficiencies and poor operating practices even though restrictive labor practices have contributed to the high costs in both line haul and terminal activities. If intermodal is to ever achieve a reasonable share of the transportation market, all parties to the operation must be challenged to perform as productively as possible. It is for this reason that research is needed in the area of achieving the full potential of the human resources in the intermodal operation.

Proposal

Identify the various aspects or components of the intermodal service where there is an opportunity for improved use of the human resources. Next, quantify the individual areas to the extent possible.

To address these opportunities for improvement, there needs to be a methodical review of programs and techniques which have been successfully employed in industry or other institutions and which might be adapted for this particular part of the transportation environment. These programs might address research in the man/machine interface, especially machine design, or it might involve employee motivation and job satisfaction, both for worker and supervisor. Concepts such as the Scanlon Plan which has been used successfully in a number of companies to encourage innovation should be studied for application to rail/truck operations. Upon its successful completion the first phase effort would logically lead to a second phase program to study the proposed project area in depth in preparation for an implementation or testing effort.

Drayage Costs for Trailer on Flatcar Shipping

Problem

Currently the costs of moving a trailer from a shipper to a railroad yard for piggyback loading or movement in the reverse direction to consignee often costs in excess of $50 and as much as $100 in many metropolitan areas. These costs are one of the main reasons why intermodal piggyback service is viewed as unattractive by many railroads and truck lines and why rates often are either too high to capture much traffic or yield very low profit for the carriers involved. Intermodal service has many potential advantages, but unless costs are controlled,

these may never be realized in practice.

Proposal

Investigate the cost composition of drayage costs in a cross section of metropolitan areas and selected rural areas in order to determine the particular elements of costs which result in the very high costs in certain larger areas. Determine the reason for substantial costs of any particular component, possible reasons being inefficient use of labor or equipment due to traffic peaking, work rules which prohibit efficient use of labor, high wage rates, inefficient equipment, etc. Give particular emphasis to the identification of changes in the system which would reduce costs.

PRICING

*Administrative and Technical Problems in Implementing Pricing

Problem

While the theoretical work in pricing strategies is well developed, there is considerable work to be done to fill gaps with respect to data and administrative and technical problems. Implementation of pricing strategies is unlikely until these can be brought up to the level of other transportation systems management alternatives such as traffic engineering.

Proposal

1. Review the existing state-of-the-art in pricing to determine research priorities. This should include analysis of what has been learned from past efforts to change the prices of urban travel, including parking fees (e.g., in San Francisco, Berkely, Madison, and Honolulu.
2. Consider ways that pricing strategies, whether for the private automobile or for public transportation, can be integrated with other strategies (e.g., Transportation Systems Management).
3. Finally, identify and describe several strategies that have worked under various conditions and apply these in controlled situations.

*Implementing Peak Tolls on Existing Toll Facilities

Problem

Existing toll bridges and tunnels generally make no allowances for the time of day or day of week. Time-of-day or week toll structures might improve the distribution of traffic and contribute to achieving transportation, environmental, and energy goals. However, mechanical and political difficulties must be overcome. Toll variation must be smooth so as to avoid jamming at time of toll change, to permit toll changes to provide inducements for small changes in travel time, and to permit inducements to be offered for shifting out of the height of the peak.

Proposal

Develop what appear to be desirable and workable real-world applications and test them to see if they accomplish the desired results. Evaluate and rank alternative methods such as:

1. Credit card systems
2. AVI (automatic vehicle identification)
3. Refund vouchers, redeemable when accumulated to minimum total value, say $10, redeemable through gas stations, etc.
4. Randomized refunds with refund vouchers as lottery tickets, refund vouchers as "instant money," refund vouchers randomly valid for subsequent gross toll, combinations of the above.
5. User identified tickets where user buys book of tickets, with magnetic serial number, deposits book stub with his name and address. He may buy several such books and as he uses tickets, refund is credited to his account and when the credit reaches the value of a book, one is mailed to him.

Risk Management for Pricing Strategies

Problem

A review of the UMTA pricing demonstration program indicates a need for ways to manage the risks of road pricing as perceived by city decision makers who are considering pricing demonstrations. Without more attention to "risk management," areawide or corridor pricing demonstrations will be difficult to initiate.

Proposal

1. Conduct "post-mortem" interviews in cities which have considered and rejected pricing demonstration programs.
2. Develop explanatory materials (preferably with graphical content) accounting for the experiences of the cities which have considered and not adopted pricing strategies,and have persons in the cities who are familiar with the proposals review these explanatory materials.
3. Analyze and evaluate risk management techniques which might be employed in pricing demonstrations. The analysis shall include liability mechanisms commonly used in high-risk, high-payoff activities, and insurance techniques.
4. Develop recommendations applicable for pricing demonstrations.

Modeling Peak Congestion and Pricing

Problem

To date, the state-of-the-art is rather primitive with respect to models which adequately represent the interactions between peak-hour charges, traffic congestion and costs, and traffic flows. Better understanding of these interrelationships will greatly facilitate planning and implementing pricing strategies.

Proposal

Develop models of the interaction between variation in user charges by time of day, desired travel patterns, and the resulting congestion. Models should be capable of being evaluated in terms of actual data, either existing or to be developed as a result of cross-elasticity studies, speed density studies, and the like.

Income Distribution of Urban Travelers

Problem

Proposals for time-of-day pricing or user charges in general for the promotion of efficiency in urban transportation are often opposed on the ground that

their incidence is regressive. Little is known in detail, however, about the distribution of incomes among the users of transportation facilities at various times and places, and much of the opposition is based on unsubstantiated and sometimes quite dubious assumptions.

Proposal

Determine the distribution of income among users of transportation facilities at various times and places. Survey techniques will be employed. Special emphasis will be given to the income differences between users of congested facilities at peak hours vis-a-vis users of these same facilities at off-peak times, and users of similar types of facilities in uncongested locations.

Railroad Costing and Rate Making

Problem

There are signs, specifically issues raised in the Ex Parte No. 290 proceedings, that the ICC is headed in the direction of relating railroad rates more clearly to costs. The railroads need the flexibility to discriminate in rate making more than ever if they are to preserve existing traffic and recover fixed costs. There is a growing conflict here that is deserving of attention. The Congress has ordered the Commission, in the 4R Act, to have more regard for the revenue needs of the railroads, yet the Ex Parte 290 proceedings may make rate discrimination more difficult.

Proposal

Analysis of railroad costs is the starting point. Assign variable costs to all shipments; then assign remaining "fixed costs" proportionally to all traffic. Doing so will reduce railroad rates on some traffic, causing loss of revenues. It will increase railroad rates on other traffic; in some cases such traffic will then be lost to competing modes, causing a further loss of revenue. Can the railroads retain sufficient traffic at sufficient rate levels needed to recover all fixed costs?

SURFACE FREIGHT REGULATION

*Reexamination of Economic Regulation of Surface Freight

Problem

The freight transport industry has changed radically since economic regulation was instituted with the Interstate Commerce Act of 1887. Competition between modes and carriers is now widespread and seems capable of doing as effective a job of protecting consumer interests as it does in most other industries. Private and exempt carriage also has grown tremendously, to the point where it appears to be undermining the system of common carriage. Does the nation need a common carrier system? And if so, is common carriage something that needs to be preserved and protected? Regulation of the freight market by the ICC has come under widespread criticism as promoting inefficiency and inhibiting competition. What valid purposes and functions does regulation serve?

Proposal

Specific questions to be studied include:

1. What anticompetitive and/or oligopolistic tendencies exist in the freight industry?
2. If common carriage is abolished, will some shippers, for whom recourse to private carriage is impractical, lose access to service at reasonable rates?
3. To what extent does cross-subsidization continue to exist and is there an argument for preserving cross-subsidies? (Who benefits from cross-subsidization if it does exist?)
4. How will the cushion of excess capacity that common carriers provide be provided if the system of common carriage is abandoned?
5. Does common carriage apply to all elements of the industry?
6. Would abandonment of the concept of common carriage create multimodal transportation companies, i. e. companies offering transport by truck, rail, barge, and air?
7. What is the role of the common carrier in spreading the cost of normal excess capacity in freight transport?

*Status and Role of the Independent Owner-Operator Truck Industry

Problem

Independent owner-operators of trucks supply a significant amount of intercity transportation. Yet almost nothing is known about the size, composition, service patterns (including observance of hours of service laws, speed limits, weight restrictions, etc.),financial status and viability, costs, rates, and inter-relationships with other systems of intercity transportation. Its role, status, and prospects need to be understood as a determinant of effective transportation policy.

Proposal

Develop reliable information and data about the industry, including scope of operations, costs, revenue, traffic, safety, relationship with the private, regulated, and exempt segments of intercity motor transportation. The results of the investigations should be presented as recommendations for how to stabilize this segment as a financially healthy and efficient supplier of transportation. A secondary result would be determination of the effect of excessive hours of service, speed, and weights on costs of owner-operators and the effect on intermodal competition.

*Motor Carrier Entry Control

Problem

The entire question of the degree of regulation to apply to intercity motor trucking has become a national issue. One of the two principal questions is the extent to which entry of new firms into trucking should be controlled. (The other is price, or rates.) Public attitudes range from status quo to complete deregulation. Within these extremes range questions of complexity of regulations (simplication), fragmentation or undue specialization and resulting inefficiency, absence of competition (service, not price), energy consumption, environmental factors,and other high social costs. Basic to all these considerations is the lack of comprehensive information upon which to base policy decisions and how entry control impacts on all elements of the public. Results of the project proposed to monitor experience in the expanded commerical zones

would be a valuable input to the project.

Proposal

Any number of specific research projects could help resolve the principal issue. Among those which should receive priority attention are:

1. Evaluation of the concept of public convenience and necessity.
2. Adequacy of service——any needs not being efficiently or effectively supplied under present conditions of controlled entry.
3. Are there any elements of traffic which would better be served with controls relaxed or eliminated?
4. Would decontrol of entry without decontrol of rates have any impact on competition with other modes?
5. Impact on employment, financial viability, highway use and development (rural, urban), energy consumption, environment, intermodal transportation.
6. Would free entry change the industry structure or supply of transport facilities?
7. What kind of data are required to evaluate entry control?

Commercial Practices in Freight Transport: Effects of Economic Regulation

Problem

More needs to be known about the commercial practices of the various modes and the ways carriers compete with one another and with other modes. The tendency of railroads to compete by supplying shippers with all the cars they request and by offering shippers a variety of circuitous routings are examples of commerical practices that are destructive to the railroads and of little value to shippers in the long run. Regulation has a bearing on the choice of competitive tactics in freight transportation.

Proposal

An in-depth examination of the commercial and competitive practices of the railroads (and other modes of transportation) by someone familiar with these practices.

Economic Evaluation of Regulatory Costing of Motor Common Carriage

Problem

Motor carrier costing has traditionally been a responsibility of the Interstate Commerce Commission as it uses such costs in the determination of rate structure and levels for common carriers. The Commission applies a complex costing formula based on territorial averages, sample data, and a host of carrier operating statistics and financial information. Preliminary analysis of the ICC procedures (Highway Form A) reveals the use of cost studies dating back to 1943, the application of average variable, rather than marginal costs, and the inclusion of accounting techniques which are inconsistent with sound economic principles. Since its inception in 1948, Highway Form B has never undergone a comprehensive and critical economic evaluation. Improper carrier costing can cost shippers and/or carriers millions of dollars annually.

Proposal

Undertake an economic evaluation of the regulatory procedures for determining the operating costs of motor common carriers with the goals of:

1. Employing a marginal cost philosophy in the allocation procedures;
2. Modernizing statistical analyses and sampling methods;
3. Accounting for more comprehensive operating characteristics; and
4. Simplifying costing outputs for easy use by shippers and carriers.

The proposed research would review ICC procedures for aggregating and allocating the approximately 100 financial accounts, its system of collecting operating data, and procedures for cost determination. Hopefully the end result would be a computerizing marginal costing procedure which would printout a matrix of operating costs (weight of shipment and length of haul) for various commodity densities by the 10 major rate making geographic territories in the U. S.

Monitor Experience With Expanding Exempt Commerical Zones

Problem

The entire question of the degree of regulation to apply to intercity trucking has become a national issue. One of the principle questions is the extent to which entry should be controlled. Indeed, the Interstate Commerce Commission recently issued a task force report recommending substantial changes in motor carrier entry control. Given the recent expansions of the exempt commercial zone, it behooves transportation researchers to monitor these zones which now have unlimited entry. Such a study would provide a microcosm of regulation and the effects of wholesale deregulation.

Proposal

1. Collect information on entry and exits of carriers, rates, bankruptcy, concentration, levels of service, effects on labor from before (if possible) and after the expansion of the commercial zone.
2. Assess the impact of these changes on shippers, carriers, environment, energy, safety, and public investment decisions.

Economic Impact of Noneconomic Regulation

Problem

Approximately 30 noneconomic federal agencies affect carrier operations. Taken separately, they may have only a small impact, but in sum they may have a large impact on certain if not all. Possibly they can destroy individual carriers or even an entire industry. For example, the recent history of safety regulations shows that noneconomic regulation can have an impact on suppliers and carriers in both the short and long run.

Proposal

Develop case histories of recent National Highway Traffic Safety Administration such as 121 truck regulations. It apparently has impacted on suppliers' production decisions, carrier purchasing decisions, and financing arrangements before and after. Included must be the effect of inflation on delayed busing patterns.

URBAN GOODS MOVEMENT

*Planning for Movement of Hazardous Materials Through Urban Areas

Problem

The amount and variety of hazardous goods that must move through urban environments is increasing as a direct consequence of general technological progress. Local regulatory/enforcement organizations often lack both expertise and authority for providing safeguards adequate for keeping accident risk at an acceptable level in the particular urban environments for which they are responsible. Conversely, in some cases, excessive and commerce-inhibiting restrictions are being imposed unnecessarily. There is no logical and objective set of guidelines applicable to a wide variety of urban situations to assist local authorities in planning for the necessary movement of hazardous goods through their cities, each of which has a unique set of terrain, traffic, and demographic properties.

Proposal

Develop a risk assessment model and associated data banks as a planning tool capable of calculating the relative risk of moving specified classes of hazardous materials through a large variety of specific urban environments by various transportation means. Major research steps will be:

1. Background studies of risk assessment methods in other fields and of the current practices in planning for hazardous goods movements in cities followed by structuring of a conceptual model geared to practical planning application by local authorities.
2. Data gathering and surveys to assemble information needed for quantifying the model with iterative restructuring of the model as necessary as the "available data" picture becomes clear.
3. Exercise and qualification of the model in a large variety of situations.
4. Development of a guidelines manual, "Planning the Movement of Hazardous Materials in Cities."

This research would best be conducted in a framework of close liaison with DOT's Office of Hazardous Materials, various industry associations such as the International Association of Tunnel, Bridge, and Tollway Operators, and representatives of shippers, local governments, and the hazarded urban public.

*Costs and Constraints in Distributing Goods to Retail Premises

Problem

There is urgent need to (1) mitigate social effects of heavy goods vehicles and (2) improve efficiency of the freight industry in the context of movements in towns.

Proposal

Examine the costs and constraints of delivering goods to a selected activity such as retailing, commodity by commodity. The practicability of alternative methods of distribution, for example, can only be assessed by looking at individual commodities distribution channels. Use is made of this approach in the Transport Operations Research group, University of Newcastle on Tyre, England. It is geared towards practical solutions and is policy oriented, unlike much USA work. More work of a similar nature is needed.

Dynamics of Urban Freight Land Use

Problem

Many interurban and a significant proportion of intraurban freight deliveries pass through a transshipment process at some point. Facilities can be a key to both understanding and planning for urban freight. Data for London, England, suggest that these land uses are highly footloose, i.e. the location of the depots changes rapidly with time. No such data are known for North America. Information of this sort would be invaluable in planning consolidation and transshipment centers; if such land uses are highly mobile, it may be possible for the planner to take steps in a short time period to introduce consolidation or more efficient transshipment centers. Moreover, if information on the reasons for the location preferences of such firms were known, this would enable the planner to know what incentives were necessary to encourage firms to locate in desirable places. The broader effects of accessibility on the sort of land use are also of importance.

Proposal

1. Examine business directories in selected metropolitan areas for various past years to determine location patterns and trends for both particular firms engaging in transshipment or consolidation, and for the industry as a whole.
2. Interview key executives of such firms to determine the reasons for their present location, reasons for recent changes (if any), and such quantifiable data as may be necessary to construct a behavioral location choice model (if a modelling approach was felt to be appropriate).

Commodity Flow Analysis and Forecasting

Problem

The nation's commodity (or freight) movement characteristics are not well established or known. The projections for future flows by commodity and mode are even more difficult. This knowledge is essential for the planning and development of all freight transportation systems improvements.

Proposal

The scope of study should cover the establishment of baseline commodity flows by origin and destination mode, commodity type, and volume. Relate these characteristics with economic, land-use, shipper and carrier parameters. Forecast commodity flows in 10-year increments through 2040 by origin and destination, mode, commodity type, and volume.

Methods and techniques for forecasting future flows by commodity and by mode are to be developed by means of the baseline commodity flows. Both aggregate and disaggregate approaches are to be developed.

Productivity in Terminal Areas

Problem

Higher productivity in terminal areas is necessary because this is the phase of freight operations

which is frequently the least efficient. For example, rail traffic in which small numbers of cars have to be delivered at very low speeds on industrial sidings in the downtown areas of major cities is handled in a costly manner and one which is sometimes complained about by people who live in these areas.

Proposal

Explore and test ways to improve productivity in terminal areas. For example, initiate the study by surveying the literature, selected shippers, and community spokesmen to learn of improved ways to handle rail traffic in downtown areas.

Effects of Transportation Systems Management on Urban Freight

Problem

In the short term, a major contribution towards lessening the environmental and economic costs of urban freight is possible through the use of transport systems management techniques such as one way streets and synchronized traffic signals. However, promoting these techniques for urban freight seems questionable until the system effects of such techniques are known. On the other hand, transport systems management techniques for passenger movement (bus lanes, bus priority, auto free zones, etc.) are being progressively introduced, and there is a real possibility that some of these may be having serious and costly impact on urban freight.

Proposal

1. Examine existing passenger-oriented transportation systems management schemes to determine their impact (if any) on freight.
2. Investigate the feasibility of developing and introducing transportation systems management schemes specifically oriented towards freight.
3. Develop an evaluation scheme to assess the merits and demerits of particular freight-oriented transportation systems management proposals, with a view to establishing their value to the community.

Workshop Papers

INDUSTRY AND GOVERNMENT RESEARCH NEEDS A CANADIAN PERSPECTIVE

Peter J. Detmold
Chairman, Railway Advisory Committee (Canada)
Special Consultant, Canadian Pacific Limited

I am delighted to have this opporunity to talk to you. When one has two titles, there is the advantage that no one is quite sure on whose behalf one is speaking, which is particularly useful if they do not happen to like what one says. I shall dispense with this rhetorical schizophrenia and make it plain that my views are my own and are not necessarily those of Transport Canada, the Canadian railways, or Canadian Pacific Limited.

Exchanges of views regarding government transport policy between our two countries are generally useful and sometimes amusing. I was tempted to say "generally amusing and sometimes useful," but I shall opt for the former.

The basis for the exchange is that Canada alters its transport policy about once a decade, whereas the United States government adjusts its policies more conservatively and less frequently. Thus, Canadian after-dinner speakers can report enthusiastically on developments in Canada up to the point when the Canadian government is about to reverse its position——which may be the point where the U. S. government is beginning to wonder if there isn't something in it after all.

More seriously, I generally believe in letting competitive forces under free market conditions determine which mode of transport should be used, but I hasten to add that I recognize that there are a number of situations in which market forces are prevented from working effectively. By the same token, I believe that research should be left to corporations wherever there are adequate incentives, but as before, I recognize that there are a number of situations in which this simply won't or can't result in adequate and effective research being carried out.

I shall begin, therefore, by considering the nature of these situations,and I shall then consider the remedies that appear to me to be most appropriate. Although I started life as an aircraft engineer, I shall generally draw my examples from the railroad industry because this is what I am involved in as chairman of the Railway Advisory Committee in Canada. It will impose a form of self-discipline and keep my feet on the ground in more senses than one.

Should governments be involved in transport research? I expect you would answer "yes." I would answer "yes" also, but with some important qualifications and with a feeling that the answer is perhaps less obviously affirmative than one would suppose.

Nearly two-thirds of the Canadian civilian labor force is employed in manufacturing industry and in a variety of occupations which are collectively known as "trade," including the service industries but excluding transportation. How much is spent by the government of Canada on research to assist these industries? I do not know of any published statistics, but I would guess that it is around $200 million a year.

But, as two-thirds of Canada's GNP is around $120 billion, and as one would guess that research effort must be at least 2 percent of gross revenue, it seems probable that the public funding of research may well be no greater than 10 percent of the total. What these numbers seem to be saying is that there is no earthly reason why companies should not carry out their own research where it is in their advantage to do so, provided that there are sufficient funds available. But, of course,

there are some industries in which there are not the funds available, and the transportation industry is amongst the most important of these in both of our countries.

There are three kinds of situations in which governments may consider it appropriate that they should become involved in transportation research. These are:

1. Where community problems result from some particular mode of transportation (e.g., the automobile) having a major influence on lifestyle and social structures, but research would be beyond the scope or the responsibility of the manufacturer of the vehicle. In short---the economist's "externalities."
2. Where there is insufficient cash available for an industry to tackle its own research problems.
3. Where some special characteristic of the industry makes it desirable that research should be pooled, or where benefit to any one operator may be insufficient, but the collective benefit to all operators and users may be sufficient to justify the expense. (This is not necessarily a reason for government involvement although they tend to be drawn in where the effort is communal.)

Clearly there are many fields for transportation research in these three categories. The first category includes research into the protection of the environment, safety, societal effects of transportation, and a great many allied issues. It is a task for governmental research agencies and universities to tackle. It is an important part of the "raison d' etre" for your own organization.

Where the second---the cash shortage---reason for government support is concerned, I think one must distinguish between research in support of operations---such as rail passenger services---which are very unlikely to be financially self-sustaining, and other research in support of potentially profitable operations made necessary because of the impecunious condition of the operators.

Milton Friedman has pointed out that, in the long term, return on investment varies little in real terms. If the flow of investment funds falls, then industry becomes less profitable and contracts in size until it stabilizes at a level appropriate to its cash flows. Surely if the real terms return on industry has a tendency to stabilize, then there is no fundamental reason why an industry such as rail transportation should be less profitable than any other industry. If this is so, then measures to restore cash flows in the railroad industry may be viewed as an alternative in the longer term to continuing to subsidize research directly. There is no basic reason why railways should be impecunious, and one hopes that public funding of research and development for this reason is a temporary phenomenon.

I mentioned a little while back that the special characteristics of railroads may justify some communal effort in railway research and that these may make some degree of government involvement desirable. I had in mind that a railroad has some inherent characteristics which are quite unlike any other transport system.

There is no other form of transport that I know of in which so many manufactureres are involved in the initial construction of the road and in the supply of the vehicles. One or more manufacturers provide the locomotives, others the cars. Someone else provides the ties, the signalling equipment and so on. Although each manufacturer sells his own equipment under warranty, the manufacturers collectively do not take overall responsiblity that any combination of their products will operate satisfactorily together. Yet they are expected to do so on a track on which the numerous combinations of gradient and curvature provide an infinite variety of unique situations.

It is almost as if an airline bought some wings from Boeing, some fuselages from McDonnell-Douglas, some stabilizers from Lockheed, some motors from Pratt and Whitney, bolted them together in any random combination and taxied out fearlessly to the take-off point. If this analogy seems rather far fetched to you, do please explain to me why it is so different from what we do every day. It would be reassuring to know the reason.

The problems inherent in this randomized system have been exacerbated over the years by forces of economic circumstance. Increasingly severe competition from trucks, and escalating cost levels encouraged the railroads of North America over the last quarter century to increase both axle loading and train length by very substantial amounts. For Class 1 U. S. railroads, gross train load increased from an average of 2630 tons in 1950 to 4130 tons in 1975. The average weight of a loaded car increased from 77.8 tons in 1950 to 105.9 tons in 1976. However, as a great many 1950 cars were still in service in 1976, the increase in the loaded weight of new production cars probably increased even more drastically than this 36 percent increase in average loaded weight.

Although I have no doubt that the railways were most circumspect in the manner in which they tested new equipment such as the large new unit trains which have entered service during the last 10 years, at no stage until recently did we stand back from current problems and examine afresh the engineering and economic qualities of the railway system as a whole. At no stage---that is---until the Association of American Railroads began their highly important series of programs into the fundamental character of the relationship between the train and the track upon which it travels. (As I said earlier, this is a reason for cooperative effort but not necessarily for government involvement).

Summing up, I believe that some government involvement in railway research is both inevitable and necessary. This is partly to make sure that community needs are adequately represented, but it stems also from the inherent characteristics of railroad systems and their tendency to be something less than perpetual money spinners.

Canadian research priorities. This is a convenient point to switch from my cursory mention of the reasons for communal research effort and talk about ways in which the government of Canada and the Canadian railroad industry are cooperating. I personally believe and hope that this cooperation will be extended to closer ties with governmental research institutes and the railroad industry in the United States.

There is little physical difference between the railroads in Canada and those in the U. S. Although we have particularly severe winters with snowfall exceeding 250 inches in some areas, it is doubtful if conditions are substantially worse than those encountered by the principal roads in the northwestern states. We have a few unique problems such as permafrost, but the scale of our operations in these areas is comparatively small. Most of our railroad---and indeed many other---transportation research problems are common to both our countries.

The Canadian Railway Advisory Committee was formed three years ago with the object of bringing about a closer liaison in which the railway industry---

including equipment manufacturers, trade unions, and research institutes---advise Transport Canada on the most favorable directions in which research programs should be initiated and funded. It was not a question of finding a new means to spend public money for the benefit of the industry---in fact, in many cases, the cost of the programs has been shared between government and nongovernment participants. It was rather that there was a growing realization that a major research effort would be needed to meet Canada's vast and growing needs for rail transportation, and that this could be provided most cost effectively by combining our forces.

Before discussing some aspects of the research programs we propose, I feel that I should say something about the philosophy on which they are based. I personally believe that the history of railroading indicates continuing need to increase productivity of labor and capital. To some extent this occurs because of technological progress in competing modes of transport, but the rising level of wages (in real terms) also makes it necessary to increase progressively the proportion of capital to labor.

I know that you would hasten to point out that there are other societal needs which may not be directly related to growing productivity, but which may be just as urgent in their demands for research funds, and indeed this may be true. But it is also true that for the railroad industry to meet new challenges such as modern, fast, intercity passenger services, it must begin the day in a sound financial state and with economic justification for its continued existence. One need only look at the problems of some European railroads to appreciate the magnitude of the economic burden on the community when it is necessary to retain a major passenger network that is allied to freight services which have long since ceased to meet the needs of the industrial community.

For many years, railways increased their productivity either by increasing the length of haul, by increasing the length of train, or by higher axle loadings. The average length of haul for Class I U.S. railroads increased from 416 miles in 1950 to 535 miles in 1976. I have already given you statistics for the other two parameters.

It is clear that we cannot make trains much longer than the present lengths—which sometimes exceed 3000 yards---without encountering severe train handling problems; in any case the economic advantage for doing so is questionable. We certainly cannot increase axle loadings above the 32.5 tons of today until we know a great deal more about the riding characteristics of trucks and their consequence upon the wheel/rail interface.

We could, I suppose, haul our loads further, but there is a limit to very long haul traffic and, as traffic is lost, there would be the need for still greater productivity improvements from remaining traffic. Before too long, "from sea to shining sea" would take on a new meaning---it would be the origin and destination for most rail traffic.

As it appears that there is little prospect for any major improvement in productivity of the large long-haul freight train, then it follows that there are only three principal areas in which substantial productivity improvements may be obtained. The first of these is in the productivity of road and equipment maintenance (including construction projects such as the elimination of severe curvature and gradients). The second is the efficiency with which we handle rail traffic at the beginning and end of the journey. The third is the greater throughput and reduced locomotive maintenance obtainable through electrification.

New equipment to improve the productivity of track maintenance surely deserves a high priority. The mechanization of track maintenance during the 1950s and early 1960s enabled the real terms cost of maintaining track per unit gross ton mile of traffic to be reduced by possibly as much as 30 percent on some major roads. I treat the figure cautiously because it is rather important to distinguish between legitimate cost saving through mechanization, and that obtained through deteriorating standards.

We need a new generation of automated rail layers, tie changers, tamper/liners, ballast cleaners, not only to reduce our costs so that we can remain competitive and contribute fully to the economic development of our two countries; we need them also if we are to continue to provide high quality track suited to the needs of high speed passenger trains, where these are socially desirable. The frequent attention that track needs in this latter circumstance and the growing volume of traffic on some main lines will make it essential that track gangs should be able to move at much higher working speeds than the 500 feet an hour that is typical today.

Higher productivity in terminal areas is necessary because this is the phase of rail freight operations which is frequently the least efficient. Some kinds of rail traffic such as unit trains carrying bulk commodities, piggyback,and container services are already handled efficiently at the end of the run. Other kinds of rail traffic in which small numbers of cars have to be delivered at very low speeds on industrial sidings in the downtown areas of major cities are handled in a costly manner and one which is often complained about by people who live in these areas.

The main point about domestic container systems is that the marine container is unsuited for domestic use because its 8' x 8' cross section does not make satisfactory use of the cubic capacity available on either rail or highway vehicles. I note that some experimental container cars aimed at remedying this deficiency are under construction in the U.S.

Regarding electrification, I shall say little as the subject was covered thoroughly at a recent conference in Washington, and you are no doubt aware of the excellent study by the Canadian Institute of Guided Ground Transport. May it suffice to say that I regard electrification as an inevitable development, but one which will come about progressively and probably without major government stimulus whenever it becomes truly economic in some specific application. I need hardly add that it will not come about unless and until the cash flows earned from railroading are brought into line with those in other industries.

I have reviewed the three most likely areas from which productivity improvements may result, but there are other areas of railroad research which merit at least as great priority. The first of these is simple. It is the need to improve the efficiency with which the railroads tackle their existing workload.

I have already referred to the track/train dynamics program of the AAR and in which the government of Canada and the Canadian railroads are involved. Perhaps I should have mentioned this ahead of the productivity improvements because in some ways we are making up for a backlog of research which we might advantageously have tackled 20 or more years ago. What could be more fundamental in research than to ensure that the trucks ride in a stable manner on the track and without causing undue wear to either wheel or rail?

Before the committee was formed, the principal railways and the government had already seen the

need to support track/train dynamics amongst other programs. There is, in fact, a close liaison and several Canadians are members of the various committees and steering groups which supervise the AAR programs. Indeed, the chairman of their track/train dynamics steering committee is a prominent Canadian railroader. Track/train dynamics apart, there are a host of other improvements to the design of locomotives and equipment which could contribute to the reliability of railroads. Prevention of winter slush from entering the ventilation exhaust ports of traction motors, and prevention of leaks in braking systems are typical examples. There is nothing romantic about such projects. Researchers who work on them are unlikely to receive Nobel prizes. But if you knew how many traction motors Canadian railways change every winter, you would appreciate the virtue of such lackluster projects. You might also buy some shares in a company making copper wire.

Lastly, there is the need to give adequate priority to the development of railway equipment of kinds that are not able to be financially self-supporting. I refer, of course, principally to high speed passenger services. Here the railways of Europe and Japan appear to have left those of North America some way behind in the development of technology regarding the trains themselves and possibly concerning techniques to maintain track at reasonable cost to the quality needed for running at speeds of over 100 miles per hour.

Some organizational developments. During the early part of this talk I mentioned the reasons for cooperative effort between governments, railroads, railroad equipment manufacturers, and others in planning research programs of the greatest community benefit. During the middle part of the talk, I discussed some of the principal research needs and priorities. Now in the last few minutes, I should like to say something about the organizational means of directing the communal effort to achieve research objectives in Canada and also concerning the need for cooperation between our two countries.

Soon after I became chairman of the Railway Advisory Committee, I decided that the first need was to set up small task forces each consisting of seven or eight of the committee members most closely concerned with the specific problem. Each of these groups consists of hard headed practical railroaders including both operators and civil or mechanical engineers, senior public servants, trade unionists, and research specialists.

The task for each group is to recommend to the government of Canada the desirable content of research programs in their specialized field over each of the next several years. I hope that within the next six to eight months the first of these programs will have been formulated and discussed with the government. It does not, of course, follow that the government is under any obligation to accept the advice piecemeal---it may have its own priorities including some that are unknown to the members. But at least a mechanism has been set up which should be able to structure railroad research programs in a highly realistic manner and in a way which maximizes the benefit to both the community and the railroad industry.

To date, one of these groups is tackling the whole problem of railroad construction and maintenance; another is tackling all problems concerned with motive power and cars. A third is concentrating on problems concerned with track/train dynamics. I hope that by the end of the year, we shall have four or five such groups hard at work.

I personally believe that a closer liaison in railroad research in our two countries would be to the benefit of everyone and will be necessary for the economic resurgence of railroading, which is both profitable and desirable. High potential energy efficiency was the original reason why railroads were built; it is likely to provide the rationale for development in the future.

I suppose that some large part of the difficulty in railroad research results from the maturity of our industry. During the latter part of the steam era, the railroads of North America attained a plateau of technological stability in terms of the design of cars and track---somewhat less so concerning locomotives. Compared with the automobile, trucking, air transport, or shipping industries between, say, 1920 and 1960, technical change was comparatively minor. Furthermore, research effort has been somewhat fragmented for reasons I have explained. As an industry, we ceased to be research minded.

Now the Sleeping Beauty period is over. The railroads have been wakened by the unwelcome kiss from the uncharming prince of mounting costs. We need a major effort to augment the rate of technological progress. Only by collective effort are we likely to succeed.

SOCIAL, ECONOMIC, AND ENVIRONMENTAL NEEDS

William A. Bulley
Director, Washington State Department of Highways

It is a distinct pleasure for me to be here today and to participate on this panel to discuss with you perhaps an outsider's view of research needs and possibilities in the social, economic, and environmental area.

I say that because it appears that I am the only representative on the panel, with the possible exception of Mr. Smith, who comes from an organization that, in effect, is "on the firing line" with responsibility to the public for producing a product which involves planning, constructing, maintaining, and managing transportation facilities. Perhaps I can share with you from the standpoint of a state highway administrator some of the problems that we face which, in turn, may generate some ideas regarding research relating to transportation that will be worthy of consideration and helpful to those who are involved in implementation of a program.

The state of Washington recently concluded the longest legislative session in history, lasting 164 days. I understand that is typical of many states, but perhaps what is not so typical is that it was the most significant session in many years in terms of transportation-related legislation.

The legislature addressed an organizational structure for overall transportation programs for the state. The Department of Transportation will become effective September 21. It is organized similar to several other states in that it will contain Divisions of Highways, Aeronautics, Marine Transportation, Public Transportation, and Planning and Budget. There is established within the Department of Transportation responsiblity and authority at the state level for developing transportation policies and a transportation plan.

Legislation also was passed to fund highways. There was $135 million in bonds authorized for capital improvements of the Washington State Ferry System, which is an integral part of the state highway system and one of the largest public transportation systems in the United States. There also was legis-

lation for continued and increased assistance to local agencies for public transportation.

The motor fuel tax statute enacted by the legislature was very significant, not only for Washington, but other states as well, because it changed the motor fuel tax from 9 cents per gallon to a percent of the total price, excluding state and federal taxes. It is a tax that is responsive to economic trends within certain limitations. The 21.5 percent of the base price at the pump will reduce if the equivalent tax in cents per gallon exceeds 12 cents or if revenues exceed by more than 5 percent the legislative biennial appropriation. Those conditions prevent unlimited revenue windfalls being generated as a result of price increases, combined with continued heavy volumes of sales.

There also are floors built in to protect the motor vehicle fund in the event the volume of sales and the price were to reduce. The tax will not drop below an equivalent 9 cents per gallon, which also represented the existing tax at the time the legislation was passed. There was considerable support for the bill, which had been passed by the legislature two years ago but vetoed by the governor. This year it passed the Senate 35 to 10; it passed the House 58 to 33. Governor Ray endorsed the bill and signed it into law.

It is not a panacea that will do all things for highways. Many agencies are funded from the gas tax in Washington. The 20 percent of the gas tax that will be used for state highway construction will allow us to maintain the integrity of the existing system, complete the Interstate within the specified time frame of 1990, and to construct a few new projects outside the Interstate system, including park-and-ride lots and exclusive bus lanes for public transportation.

However, since the bill became law, there have been enough signatures collected to place an Initiative on the ballot for a vote by the people in November to repeal the additional tax. Some sponsors of the Inititative have indicated they want a strong highway program but no additional taxes. How does one respond to that type of dichotomy, especially with the inflation that has occurred over the last several years and obviously will continue to occur?

Many states have attempted similar legislation for increases in revenues. Most attempts have failed.

My point for dwelling on the subject of financial problems to this extent is because it appears to many there is a need for research to assist transportation agencies, legislators, and others in communicating to the people the importatnce of a good transportation system for continuation of the economy of the nation. I do not mean to limit the benefits of a transportation system just to the economy but also to the social and recreational activities of the nation today. If the public does concur with the need for a transportation system, it also would be helpful if policy makers were able to communicate to the public its responsibility for funding such a system.

I would also like to share with you some significant issues, concerns, or questions that were raised by the legislature, by the public, or by our department during the session. Many of these could be the basis for research activities.

1. The need for a defined energy conservation program. We in the state of Washington fully recognize the need to conserve our limited resources, including our energy resources. Many of us also feel it must be done in a manner that will not at the same time adversely affect the economy of the state or the nation.

The legislature and the public look to the transportation systems and systems to manage that transportation plan. It is important that the transportation agency know what is the energy policy at both the state and the national level in order to plan for the future. There have been many declarations of policy regarding energy conservation, but there also has been public unwillingness to accept them in most cases. I imagine much of the opposition is our reluctance to accept changes that are required in our individual life style by reason of the policies. So nothing happens, and consumption continues to increase.

Perhaps research could be considered regarding attitudinal changes of the public to accept policies that are in the best interest of the nation.

2. Development of a transportation policy. Once an energy policy is determined and implemented, it serves as a basis for development of transportation policies. I realize it is beyond the scope of TRB to be involved in research for development of other, more efficient means of transportation. But is it beyond the scope of TRB to determine what types of transportation the public is willing to accept within resources available? Then while industry and government are hopefully researching the development of more energy-efficient vehicles and new energy sources, could the TRB be involved in research of systems that will accommodate the implementation of the findings of government and industry?

For example, we read that some companies have made significant progress in development of motor vehicles powered by electricity or other types of energy. If we continue to use automobiles, it will require highways. However, in most states, revenues for highways are generated from gasoline taxes. If electric automobiles do become feasible, what then are feasible alternative funding methods for states to use to maintain transportation facilities that historically have been financed from the gas tax? I realize there are many answers, but in reaching conclusions our legislators need information and facts that can be readily available to them.

3. Another issue is the efficiency of the processes associated with our transportation program. This is a problem about which I, as an administrator, have great concern. It relates to the effectiveness of regulations, laws, and procedures under which we currently operate. It would mean to some degree diverting some of our research efforts from new, innovative, and imaginative ideas to an evaluation of where we are today and to what extent actions in recent years have affected our efficiency and the cost of developing a product. If implementation of new rules and regulations continues to increase the cost of the product as in recent years, the public will soon refuse to pay for additional transportation facilties.

In recent years there have been many new laws, rules, and regulations adopted, primarily in the social and environmental fields. I recognize that a need has existed to develop evaluative methods, prescribe more precise procedures, and establish standards. Now that we have had more experience in identifying and evaluating impacts, it appears to me that research is needed to examine all of the 16 federal statutues and the numerous regulations that relate to some phase of social, economic, and environmental factors regarding public works and to determine how we can protect the environment and yet insure that necessary facilities are constructed in a timely manner. Obviously, this problem affects not only highways but all forms of transportation.

The state of Washington has attempted to recognize and respond to environmental concerns. In

doing so, we have tried to provide leadership wherever possible. The Department of Highways plans to maintain a very positive attitude in this regard. We fully recognize the need to conserve our very limited natural resources. There are very few areas that have the natural beauty of our state, and we want to make sure that his beauty is not destroyed. However, there must be a responsible attitude concerning the economy of the area and efforts to avoid inefficiencies and excessive costs. An adequate transportation system is, indeed, one of our basic resources and is an important factor in the total environment that must be protected. Our transportation plan will work toward the accomplishment of these objectives.

In the State Highway Department, we have reduced our total number of employees by about 1,000 or about 20 percent, in the last six years. Much of this reduction is due to management programs that have increased our efficiency in engineering and maintenance through development of work standards. Part of it is because of reduced workloads.

During the same time, we have had thrust upon us more than 350 manyears per year for new requirements, procedures, and tasks at the federal, state, and local level. We have identified those tasks and the resulting costs in both manpower and dollars. For example, 240 of those manyears are in the construction field alone, which includes design, right-of-ways acquisition, and construction. Included in those 240 are 70 manyears to accomplish the additional environmental requirements at a cost of $1.4 million. The action plan costs $400,000 and requires 23 manyears. Totally, the cost of the 350 manyears is $6 million per year.

This does not include the cost of delays that occur by reason of some of these requirements, nor does it reflect the increased cost of the product resulting from lawsuits for alleged noncompliance. An example is a short section of Interstate 90 about 50 miles east of Seattle. The project was underway when it was enjoined from further work for noncompliance with NEPA. Because most of the work was underway, we could accurately estimate the cost of the project to be about $28 million.

After three years of rewriting the impact statement and providing a 4(f) statement for an area that was not directly affected by the facility, the courts have authorized construction to proceed with almost identically the same design as was previously contemplated. The cost of the project today is in excess of $45 million. The additional cost by reason of the delay was more than $17 million.

It is one of the smallest of several projects that have suffered delays as a result of litigation. We also estimate, based upon projections of accidents, that if the delay on that one relatively small project had not occurred, there would have been 120 less accidents, there would have been 127 people not injured, and 7 people would not have died as a result of accidents during the delays. Delays and inconveniences to the travelling public during the period of the injunction was 60,000 manhours.

There have been several other Interstate projects held up for some two to five years by reason of litigation relating to environmental regulations and laws. Total costs today of those projects are about $800 million. We estimate that at least $300 million of that total represent increased costs by reason of the delays.

Should not research be conducted to determine if environmental laws are effectively accomplishing the intent of the legislation or if they are being used in some cases to bring about delays that have tremendous social and economic ramifications? The research might also include whether it would be desirable for the litigant to assume some responsibility for increased costs in the event the agency has been found to be in compliance.

Again, let me say that the Washington State Highway Department shares a true concern over environmental damage, and we concur with the intent of legislation to protect the environment. The question we ask is whether that intent is being violated by reason of unnecessary regulations and delays that affect the efficiency and accomplishment of the intended purpose.

There is another activity implemented in recent years that, in my opinion, warrants examination of its effectiveness through additional research. It is the requirements associated with urban transportation planning.

I fully recognize and appreciate the need for close coordination of transportation planning with land-use planning and also the need for regional planning organizations. A recent study by the American Association of State Highway and Transportation Officials indicated that in fiscal year 1977 there was nearly $135 million programmed for transportation planning in urbanized areas in excess of 50,000 population. Many of these regulations are time-consuming and require great numbers of resources to accomplish. The question I ask is whether the extreme cost is justified or could the job be accomplished more efficiently?

Public involvement is a very important element in transportation planning. Many requirements have been adopted to insure public involvement at all levels of transportation activities.

In the state of Washington, we have utilized various methods to involve the public in the development of individual projects, and we have been quite successful in most instances, although we have had some failures. In the program development phase, we have conducted meetings throughout the state, but various conditions prevented the use of the same type of approach that we have undertaken for projects. In the development of our program, last year we held 52 meetings. Attendance at these meetings ranged from 15 to 40 people. Approximately 1,200 people were in attendance out of a statewide population of approximately 2,000,000 adults. These meetings were duly advertised and publicized with the help of the news media. We need research concerning the effectiveness of public involvement programs, especially in program development.

We are planning now to utilize coordinated meetings with local elected officials, planning commissions, and as many citizens as will attend. By this procedure, we at least know we are communicating with local officials and their staffs, and hopefully we will receive more public input than we did under previous plans. But we recognize that a variety of different methods must be utilized if the public is really going to become involved. In the program development stage, we need to ascertain whether the public really cares, and if not, what methods will develop their interest at an earlier stage. We know from experience that various groups become involved very actively as projects progress through the planning, design, and construction stages.

Research concerning the effectiveness of public involvement schemes, in our opinion, is important. At the same time, perhaps we could find out if the public does really care and if not, how do we develop their interest at an early stage?

Before closing, I would like to share with you a rather unique process that was used in resolving a difference in opinion between various agencies affected by the construction of I-90 in the vicinity

of Seattle. The six agencies directly affected by the project have been in disagreement over the configuration and number of lanes since the late 1960's. The project has been in litigation since 1972 and enjoined by the courts from further right-of-way acquisition or construction since 1973.

Following completion in early 1976 of additional hearings ordered by the courts, it was apparent the disagreement among the agencies still prevailed. The department concluded that we needed the services of a professional mediator to try to resolve the differences and reach a common agreement.

Through the efforts of a local mediator that was sponsored through Ford Foundation and Rockefeller Foundation grants, we were able to reach accord with all of the involved agencies on a design configuration for the facility. A memorandum agreement has been entered into by the affected agencies that not only identifies the design configuration for I-90 but also obligates the agencies to work toward solving other transportation problems throughout the area.

With the agreement, the final environmental impact statement has been rewritten and submitted to the Federal Highway Administration and to the Department of Transportation for approval. Our plan calls for returning to the courts to demonstrate satisfaction of their requirements later this year and hopefully have the injunction lifted so that the project can proceed. Research relating to the effectiveness of formal mediation processes to resolve highway problems may be of interest to many states.

In summary, I suggest that we need to continue research to identify new and imaginative fields in all areas associated with transportation. In part, however, I feel we should be monitoring the effectiveness of what we are doing, what we have done, and what we are required to do. I believe that all agencies should be willing to honestly evaluate that research and be willing to change existing rules and regulations if it would result in more efficiency as well as being responsive to the nation's needs. The findings of the research, I am sure, also would be useful to those who are responsible for establishing the law of the land and whom I feel also are willing to evaluate its effectiveness and to respond to changes as may be needed.

TRANSPORTATION PROBLEMS AND RESEARCH NEEDS IN THE RURAL SECTOR

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The objective of this paper is to present a series of recommendations regarding research needs on social, economic, and environmental problems in rural transportation. To substantiate the need for the suggested research some background is presented describing the evolution of the rural transportation system and itemizing some of the present serious problem areas in the system.

The Evolution of the Rural Transportation System

Our rural transportation system has evolved in several stages which are distinguished by competition between the different modes of transportation. It also should be recognized that the development of our economy has been greatly influenced by the progressive development of the transportation system.

The Turnpike Era. At the time of the founding of the country, 200 years ago, the inland transportation system mainly consisted of a few north-south trails, suitable for horse and rider. Freight was principally moved on water, and the population was concentrated near ports along the Atlantic seaboard.

With the advent of the Conestoga wagon (around 1750), a means of land transportation became available, and the development of "Turnpikes" commenced, constructed both by the states and by private companies. The first involvement of the federal government in road building was authorized in the Ohio Statehood Act of 1802. It is interesting to note that three years ensued between the authorization of funds by Congress and the beginning of the route location studies. Planning continued for eight years and then the Cumberland Road was constructed for a distance of about 130 miles in less than four years, being completed at Wheeling on the Ohio River in 1818. It is not recorded how many pages the Environmental Impact Statement ran, but this pattern of "planning a road to exhaustion" has been carried over in federal-aid projects to this day.

The Water Transport Era. The invention of the steam engine permitted the development of steam-powered boats in the early 1800's. Soon thereafter a major effort was concentrated on the construction of waterways and canals, and by the 1820's the cost of water transport was less than half that of wagon transport.

The Rail Transport Era. Shortly after the middle of the 19th century railroads began to displace water transport as the most economical and hence most attractive mode. For example, tonnage on the New York State canals peaked in 1880 and began a decline which was not reversed until the 1920's.

As the mileage of railroad track began to mushroom in the last third of the 19th century, every city and rural hamlet wanted to be located on a rail line. Financial incentives stimulated frantic and excessive rail building which continued into the early 20th century.

The Highway Era. Throughout the period of development of water and rail transport in the 19th century, roads continued to be built. The road system grew from a few thousand miles of trails and turnpikes in 1800, to about 2 million miles in 1890, slightly more than half of the present road mileage.

The roads served mainly as feeders to the rail and waterways systems. Little or no attention was given to their engineering or maintenance, and as a result their trafficability was highly seasonal. Farm products could be moved to the railhead for shipment to market only at certain times of the year.

In 1893 Congress mandated rural free delivery of mail, contingent on the availability of improved roads. In 1895 Congress established the Office of Road Inquiry, which has evolved into the present Federal Highway Administration. By the turn of the century, the advent of the automobile and the truck had created further pressure for improved roads.

In 1905 there were 77,000 automobiles registered and 1,400 trucks. By 1916 those numbers had grown to 3,400,000 and 250,000, respectively. And in 1916 Congress passed the first Federal-aid Highway Act, for the purpose of financing post roads to facilitate rural mail delivery and to "get the farmer out of the mud." The highway era was well on its way.

Summation. It can be seen from the preceding brief review that the rural transportation system has evolved as the consequence of improvements in technology. This has resulted in an uncoordinated, multimodal transportation network in which one mode or another is overbuilt in some regions of the country. Responsiblity for regulation of this system

lies with a multitude of agencies, and they suffer from the lack of a single, national policy framework, within which decisions could be made in a systematic manner.

It should be clear, however, that economic forces (transportation costs) have had a significant influence in the system evolution. If a governmental regulating agency had taken a protectionist stance toward waterways in the mid-nineteenth century, the railroads and highway systems might never have developed to provide lower cost freight transport. Thus we must be cautious today in approaching policy development and system regulation. We must find out how to improve the efficient operation of the transport system, without merely maintaining the status quo.

Problem Areas in Rural Transportation

The importance of the rural transportation system to our nation's economy is illustrated by the fact that the single bright spot on our international balance of payments ledger since 1970 occurred in 1973, the year of the big Soviet grain deal. An examination of the statistics for 1973 and the previous year shows that all but two percent of the favorable trade balance can be explained by an increase in agricultural exports.

It is clear that our nation's financial health depends heavily on exporting agricultural commodities. And people in other countries are increasingly relying on us for food. But the Soviet grain deal also showed us that our transportation system, particularly our railroads and waterways, were not prepared to move significantly increased quantities of farm products from the farm to port for international shipment. Grain was backed up on sidings and in silos for more than a year in that particular instance.

Railroads. As noted previously, during the late 19th and early 20th century the railroad companies greatly overbuilt their trackage, extending service to rural areas through many miles of spurs and feeder lines. This overbuilding was especially prevalent in the northeastern and midwestern parts of the country.

The year 1916, when there were 254,000 miles of line-haul track in the U. S., marked the peak of railroad mileage in this country. A steady decline in mileage has ensued, such that by 1973 the total was reduced by nearly 20 percent, to 201,000 miles. Bankruptcies of the major northeastern rail companies resulted in federal reorganization into the Consolidated Rail Corporation (Conrail), but the trend toward retrenchment has continued. In 1972 the U. S. Department of Transportation recommended the abandonment of an additional 78,000 miles of track, nearly 40 percent of the present system.

Since 1920 the Interstate Commerce Commission (ICC) has been charged with the responsibility of evaluating applications for abandonment of railroad trackage. There have been many of these applications, and most of them have been approved. For example, from 1960 to 1973 the ICC received 1,937 applications to abandon a total of nearly 31,000 miles of track, the overwhelming majority of these requests were granted, about 100 were dismissed without decision, and only 47 were denied. In the last five years, there has been a significant increase in the number of applications received each year, affecting nearly every state in the nation, but primarily concentrated in the cornbelt and the northeast.

The question arises regarding what happens to the farms and rural businesses such as granaries and fertilizer dealers which lose their rail service. Recent research reported by the Federal Railroad Administration, by the U. S. Department of Agriculture-Economic Research Service, and by Iowa State University indicates that farmers would shift to truck transportation, with a trend toward larger capacity(and thus heavier) vehicles and more frequent trips. Some researchers have found that the transportation costs for farm goods would increase, while others have predicted that the increases in revenue from truck taxes would not be sufficient to pay for the increased highway maintenance costs generated by the additional truck travel.

While the ICC should want to strive to improve the economic efficiency of the rail transportation system, it should be cognizant of the fact that rail abandonments have impacts beyond the balance sheet of the rail company involved. Improved procedures need to be developed for the evaluation of rail abandonment applications which will specifically take into consideration the ability of other modes to absorb the traffice. In particular, as we shall see in the following paragraphs, such improved procedures need to be able to evaluate the structural adequacy of highways and bridges.

Highways. Of the 3.8 million miles of highways and streets in the United States, only about 630,000 miles are in urban areas; the remaining 3.2 million miles (84 percent) are rural. With about three-fourths of our population located in urban areas, some people might argue that there is a disproportionate distribution of highway and street mileage. Nevertheless, in 1973, 43 percent of all passenger travel and 58 percent of all truck travel was reported by the Federal Highway Administration to occur on the rural transportation system. About one-fourth of the rural travel was on local (or feeder) roads, and three-fourths was on main rural roads.

But what of the condition of the rural highway system? Despite our concerted efforts during the past 50 years to "get the farmer out of the mud," 23 percent of the rural highway system remains unpaved (only about 4 percent of our urban mileage is unpaved). Another 59 percent of the rural mileage is categorized by the Federal Highway Administration as being of "low load-bearing capacity." The vast majority of these roads are under county and township jurisdiction and are mainly located in the midwest and the west. Nevertheless, overall approximately 82 percent of the rural highway system could be described as being structurally deficient. These are the roads which serve the quarter of our population that is rural, and which carry about half of our total motor vehicle travel each year.

In most rural areas there is a striking difference between the design standards and the structural adequacy of the main arterial highway system, as compared to the local feeder road system. The higher standards for the arterial system are usually justified in terms of the greater traffic volumes that are served. But in recent years there has been considerable public pressure for improving local feeder road standards. Governmental and quasi-governmental (AASHTO) regulations have moved in the direction of higher standards.

Responsiblity for the feeder road system usually rests with local government such as the counties, townships, etc. These governments often face problems in raising revenue because of their small tax base. There always is a trade off between spending larger sums of money initially for better quality highway construction with resultant lower maintenance costs. Many of the present inadequacies of the rural highway system are due to the fact that the local governments cannot financially or politically take the necessary steps to appreciably improve the situation. The importance of rural transportation to

our national economy suggests that we need to revise our present policies to encourage federal/state/local cooperation in solving the rural highway dilemma.

Bridges. The final results on the nationwide survey of the condition of our 563,000 highway bridges are not yet published. But at the present time we do know that on the federal-aid systems alone, there are almost 40,000 bridges that are either structurally deficient or functionally obsolete. In a 1971 study of bridges, the Federal Highway Administration reported that about one-fourth of the inadequate bridges were located on the federal-aid highway system, and the remaining three-fourths were on state and local systems. Thus when the final count is in, we might expect to find more than 150,000 inadequate bridges, and all evidence indicates that far more than half of these will be on the rural highway system. Using the analogy that a chain is no stronger than its weakest link, the presence of so many inadequate bridges and weak pavements on the rural highway system gains tremendous significance, especially with regard to its ability to absorb heavier and more frequent farm-to-market freight movements due to railroad abandonments.

Research Needs in the Rural Transportation Sector

What then does all this mean in terms of research needs in the rural transportation sector? By means of conclusion some suggestions are offered.

1. Optimal Use of the Present Transportation System. In most areas of the country it must be conceded that we presently have an adequate or even an excessive multimodal transportation system. We need to develop improved procedures for modeling the existing system, with a view to answering the question of how we can optimize the utilization of the system. Perhaps the most logical criterion for optimization would be to minimize the cost of moving goods to and from the farm.

Such an optimization will require multimodal coordination at a level far beyond present capabilities. Studies need to be continued which will investigate the incentives and disincentives to transportation due to current governmental regulatory policies, subsidies, etc. Because of intermodal competition and other problems, communication between different modes of transportation and with organized labor involved in transportation, is presently inadequate and shows no signs of immediate improvement. Resistance to the increased use of containerization in the movement of freight is an example of this problem. Research needs to point the way to improvements in this situation.

2. Optimizing the Extent of the Transportation System. This area differs from the preceding one in that it does not accept at the onset the idea that we must live with the present transportation system.

Procedures need to be developed which will enable the identification of regions which have too much (or too little) transportation. For example, how can we decide whether or not there are too many roads in a rural area? If there are too many roads, which ones should be eliminated? Is there a factual basis from which such decisions can be made, or must the decisions finally be made in a political environment?

3. Optimizing the Organization of the Transportation System. It can easily be conceded that excessive redundancy in the transportation system is an economic waste. In the private sector techniques need to be developed which will permit the identification of an optimal balance in terms of number of firms, modes, size of facility, etc., to maintain a competitive but not wasteful transportation system. Certainly there is no single balance point which can be struck here, and the challenge lies in encouraging a free economy without excessive governmental regulation and yet also without economic waste.

In the public sector regulation can be implemented more easily, but politics often create barriers to change. Techniques need to be developed which will enable us to identify where economies of scale could be realized. For example, many of the older states, particularly those in the northeast and midwest, have township highway organizations as well as counties, cities, villages, etc. On the other hand, the southern and western states have many fewer governmental units responsible for streets and highways. How can we determine what benefits (or costs) might accrue if the number of governmental units in a region were to be reduced? What cultural or political questions would need to be addressed in those regions of the country where the concept of local (small and close to the people) government is highly regarded? It is often said that bigger is not necessarily better, but how can we assess this quantitatively? Could improved intergovernmental coordination obviate the need to abolish governmental units? Where and how do these possibilities exist?

4. Optimum Land Use. How can we identify the "best use" to which abandoned transportation facilities (either highways or railroads) can be put? To what extent is this affected by regional attitudes? For example, perhaps in some parts of the country local opinion would hold that an abandoned right-of-way should be made into a bikeway, whereas elsewhere it would be deemed preferable to return the land to crops, or some other use.

We should reexamine the old shibboleth that "improved transportation reduces the cost of farm goods." In certain suburban areas, for example, the construction of a high-speed, controlled-access road will intensify the demand to convert agricultural land to housing. Where local policies require that such land be taxed for its "highest use," the cost of farm goods must necessarily go up, as the direct consequence of the improved transportation. How can we better predict such consequences?

5. Standards. Governmental policies regarding standards sometimes fail to have the desired effect. In the railroad industry, mandated standards for track and safety have occasionally forced line abandonments. Similarly in highways it is questionable how much safety we can afford. Does a rural road which mainly serves to provide access to a few farms, and which carries only a few cars per day, need to be built to the same design standards as a rural arterial? The current trend in federal standards would suggest that we believe the answer is "yes." Is there a way that we can determine on some absolute basis what standards should be required? To what extent does public attitude dictate the minimum standards which must be adopted? And if the standards for different segments of a transportation system are not the same, how can we avoid consequent questions of legal liability?

Temporal standards, such as spring time load zoning of rural roads, can sometimes be counterproductive. For example, in an effort to reduce the serious fatigue damage that rural roads in northern areas experience during spring thaw, load limits are posted on these roads. It is often the case, however, that the restrictions are posted too early in the winter, long before the softening begins, and they are removed too late in the spring. The consequence of this practice is to hinder the farmers

adjacent to the road in trucking goods to and from the farm, thereby increasing his transportation costs. On the other hand, if he ignores the restrictions, increased road maintenance costs will raise his taxes. Researchers need to find improved methods for determining load limits and when to post them, and the costs of establishing or not establishing such limits need to be identified.

Conclusion

Thank you for the opportunity to review with you some of the problems and research needs of rural transportation that I see. It is usually far easier to point to the problems than it is to find their solutions. Perhaps some of the problems I have described cannot or will not ever be solved. Nevertheless, I hope that my observations will pose some challenges to you.

TRANSPORTATION ENERGY CONSERVATION: RESEARCH NEEDS AND POSSIBILITIES

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I am pleased to participate in this introductory session of the Workshop on Research Needs hosted by the Social, Economic, and Environmental Section of the Transportation Research Board. Only four short years ago---prior to the Arab oil embargo---no one, and most certainly no American, would have given a second thought to energy in developing a list of "Social, Economic, and Environmental Research Needs and Possibilities." Yet, as I shall try to demonstrate, energy extravagance has been a basic aspect of American transportation and now pervades every major issue facing the transportation sector. Accordingly, the transition from an era of cheap, plentiful energy to one of expensive, scarce energy will require pervasive adjustments on the part of a sector as energy-intensive and energy-consumptive as transportation is. The adjustments will affect both the consumption of energy in transportation and the transportation of energy.

Background. Transportation now accounts for one-fourth of the energy and one-half of the petroleum consumed in the United States. Prior to the embargo during the winter of 1973-74, there was a long-term secular increase in U. S. transportation energy consumption per capita, due to (1) increases in vehicle miles of personal travel per capita and in freight ton-miles per capita, (2) increases in modal energy intensities, and (3) shifts toward more energy-intensive modes. Modal energy intensities increased due to:

1. Higher vehicular speeds,
2. Better performance capabilities,
3. Greater use of energy-consuming accessories such as air conditioning and power steering, and
4. Lower fuel efficiencies resulting from the emission control technologies selected by the automobile manufacturers to meet the Clean Air Act standards.

In addition, there was a gradual shift from energy efficient modes to energy-intensive ones, particularly from rail and transit to truck and auto.

Energy Conservation. Until recent months, conservation has been relatively neglected as an option for dealing with our national energy problem.

There are a number of obstacles to conservation in the United States. First, we have an institutional preference for developing new energy supplies rather than managing old ones. With our historical growth-at-any-cost mentality, we have traditionally found it politically, socially, and economically easier to divide a bigger pie than a constant one.

Second, we have a first-cost bias in our purchasing decisions. Both individuals and firms tend to pay more attention than economic rationality would suggest to initial capital costs and less attention to subsequent operating and maintenance costs. Thus, for example, in the purchase of a water heater, people tend to minimize the investment cost (by buying a cheaper, energy-inefficient model) rather than to minimize the total discounted cost over its economic lifetime (by buying a model which costs slightly more at the outset but which is significantly cheaper to operate in terms of energy consumption).

Third, conservation investments frequently were uneconomic when oil and natural gas prices were artificially low. These habits of mind persist even though they are obsolescent in the light of today's and tomorrow's prices.

Despite these obstacles, energy conservation has the following advantages:

1. The energy savings of conservation are relatively immediate, while energy resource development generally involves long lead times,
2. Conservation is often environmentally attractive in comparison with energy resource development,
3. Conservation is often most cost-effective in that the cost per barrel of energy saved is less than that of energy produced; in addition, a barrel saved is available for future use.

Due to these advantages, energy conservation is the cornerstone of the proposed National Energy Plan.

It seems clear that the transportation sector can make a significant contribution to energy conservation, by means such as the following:

1. Technical improvements in the fuel efficiency of vehicles,
2. In-use improvements in routing, scheduling, load factors and operating characteristics, and
3. Diversion of demand to more fuel-efficient modes or substitutes.

Further, in my opinion, such actions to conserve energy in the transportation sector can be equitably achieved without undue burdens upon anyone and without fundamental changes in life-styles.

Transportation Energy Conservation: Existing Programs. Chronologically, the first legislative action involving transportation energy conservation was the 55 mile per hour national maximum speed limit. First enacted on January 2, 1974, during the Arab oil embargo (Emergency Highway Energy Conservation Act, Public Law 93-239), the 55 mph speed limit was subsequently reenacted on January 4, 1975, as permanent legislation (Federal-Aid Highway Amendments, Public Law 93-643).

The Energy Policy and Conservation Act (Public Law 94-163), enacted on December 22, 1975, contains the following transportation energy conservation provisions:

1. Automobile Fuel Economy Standards. The production-weighted average fuel economy of each

manufacturer's new car fleet is required to equal or exceed 18 miles per gallon in model year 1978, rising gradually to 27.5 miles per gallons in model year 1985 and thereafter.

2. State Energy Conservation Grants. FEA is authorized to make grants to states for, among other things, (a) programs to promote the availability and use of carpools, vanpools, and public transportation, and (b) traffic laws or regulations permitting right turns on red traffic lights.

3. Energy Conservation in Regulated Industries. The federal transportation regulatory agencies (Civil Aeronautics Board, Interstate Commerce Commission, Federal Aviation Agency, and Federal Maritime Commission) and the Federal Power Commission are required to consider the impacts of their decisions on energy conservation and efficiency.

Transportation Energy Conservation: Proposed Programs. President Carter's National Energy Plan sets forth the following goals for 1985:

1. Reduce the annual rate of growth in energy demand to below 2 percent,
2. Reduce gasoline consumption 10 percent below its current level,
3. Reduce oil imports from a potential level of 16 million barrels per day to 6 million barrels per day,
4. Establish a strategic petroleum reserve of 1 billion barrels,
5. Increase coal production by two-thirds to over 1 billion tons per year,
6. Insulate 90 percent of existing American homes and all new buildings, and
7. Use solar energy in more than 2 1/2 million American homes.

The President has proposed the following transportation energy conservation actions to help achieve the foregoing goals:

1. Excise taxes and rebates on new automobiles. The purchaser of a gas guzzler which fails to meet the mandatory fuel efficiency standards established under the Energy Policy and Conservation Act would be required to pay a tax of as much as $2,488. On the other hand, the purchaser of a fuel-efficient new car which exceeds the standards would receive a rebate of as much as $500. The excise tax receipts and rebate expenditures would net out to zero.

2. Standby gasoline taxes and rebates. If total gasoline consumption exceeds prespecified targets, a standby gasoline tax would be triggered. The tax could be increased or decreased by 5 cents per gallon per year, depending on gasoline consumption, but could never exceed 50 cents per gallon. If the tax were triggered, the revenues would be rebated on a per capita basis. Thus, a family consuming a relatively small amount of gasoline would receive more in rebates than it would pay under the standby gas tax.

3. Light truck standards, taxes, and rebates. Light trucks, such as vans and pickups, would be covered by similar fuel efficiency standards, excise taxes, and rebates. This segment of the motor vehicle market has been growing very rapidly in recent years.

4. Removal of 10 percent excise tax on intercity buses. Intercity buses are a fuel-efficient mode of passenger transportation and should be encouraged.

5. Increase in fuel taxes on aviation and motorboats. The current federal tax on aviation fuel would be raised to 11 cents per gallon, except for commercial airlines and farming. The partial rebate of motorboat fuel would be eliminated.

6. Increase in federal auto fleet efficiency. By Executive Order, the fuel efficiency of the federal automobile fleet will be increased through the purchase of new cars which exceed the mandatory average fuel efficiency standards by 2 miles per gallon in 1978 and by 4 miles per gallon in 1980 and thereafter.

7. Federal employee vanpooling demonstration program. The federal government would purchase 6,000 vans for use by federal employees in commuting to and from work. Acquisition and operating costs would be paid by vanpool riders.

In addition to the foregoing proposals, the plan:

1. Encourages the states and municipalities vigorously to enforce the 55 mph speed limit and notes that the secretary may withhold Highway Trust Fund grants to states which fail to do so,
2. Indicates that inspection and maintenance programs to measure emissions may achieve a 2 percent saving in gasoline.
3. Commits the Administration to develop a program to compensate states for revenue losses from their state gasoline taxes, and
4. Notes the significance of mass transit as a fuel-efficient mode of transportation.

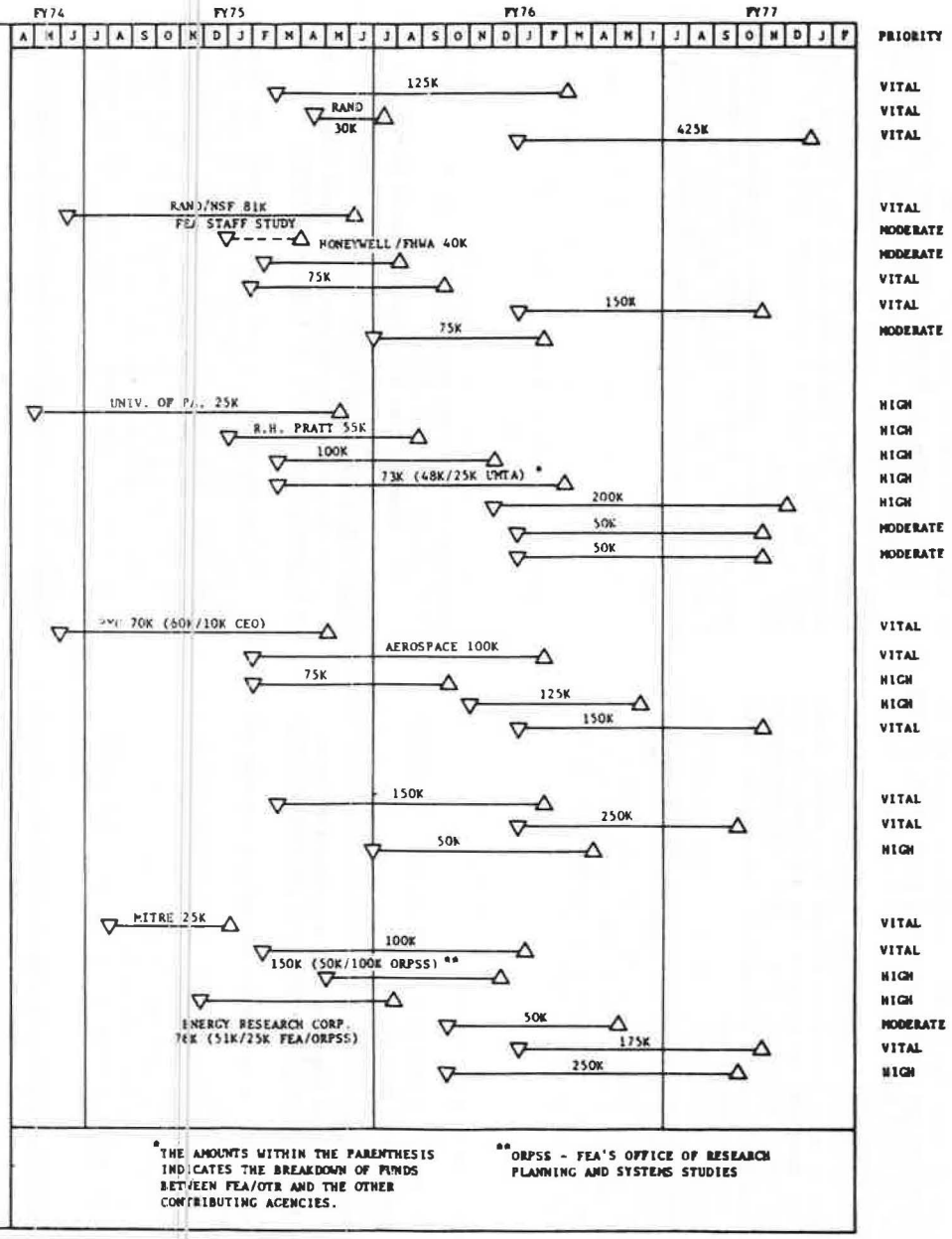
Policy Research. I believe that both the transportation and energy communities need to pay more systematic and more explicit attention to the linkages which should exist between policy research and policy development. Policy research should address current or emerging issues to shed light on the consequences of alternative policies. Policy development should inform research of current or emerging issues in a timely or anticipatory manner and in terms that are relevant to the decision making process.

The reader should be forewarned that I am excluding purely technological research from consideration because I think that most of the important, interesting, and researchable issues in transportation energy conservation are primarily institutional, political, economic, social, attitudinal, and/or behavorial rather than technological. Accordingly, I congratulate the sponsors of this workshop for arranging an excellent forum in which to discuss these issues. I also applaud the selection of Morgantown as the site for the workshop, for it is here that we built a personal rapid transit system by designing the guideway before we designed the vehicle before we designed the software and put it all in an area that teaches us virtually nothing about institutional arrangements, political acceptability, economic demand, income redistribution, or esthetic intrusion.

Believing that there are better ways to conduct research, development, and demonstrations, FEA contracted early in its organizational existence with the MITRE Corporation for a comprehensive, systematic research plan to address the issues involved in transportation energy conservation. (1) While FEA did not blindly follow every detail of the plan, the agency agreed with both its general thrusts and the bulk of its specified recommendations. For this reason and because the plan represents a rare effort to relate research, development, and demonstration projects to policies, issues, priorities, and each other, I have reproduced a summary chart from the report.

In carrying out the research plan, we frequently found that we needed to advance the state-of-the-art in a particular area of transportation before

OFFICE OF TRANSPORTATION RESEARCH PROJECTS



I. AUTOMOBILE FUEL ECONOMY
- A. FEDERAL POLICIES FOR IMPROVING NEW CAR FUEL ECONOMY
- B. EFFECTS OF A GOVERNMENT SUBSIDY FOR EFFICIENT AUTOMOBILES
- C. FEDERAL POLICIES FOR IMPROVING AUTOMOBILE FUEL ECONOMY

II. IMPROVING EFFICIENCY OF AUTOMOBILE USE
- A. PRICE ELASTICITIES OF DEMAND FOR GASOLINE BY REGION & INCOME CLASS
- B. 55 MPH SPEED LIMIT, EMPHASIS ON ENFORCEMENT
- C. URBAN TRAFFIC FLOW MANAGEMENT
- D. CARPOOLING IMPACTS
- E. CARPOOLING IMPACTS (CONT'D)
- F. IMPROVED DRIVER HABITS & AUTO MAINTENANCE

III. URBAN TRANSPORTATION
- A. PHILADELPHIA - LINDENWOLD HIGH SPEED LINE: ENERGY CONSERVATION IMPACT
- B. URBAN MODE SHIFTS: IMMEDIATE ACTION
- C. URBAN TRANSPORTATION: ADDITIONAL ISSUES
- D. SOCIAL COSTS OF URBAN TRANSPORTATION MODES
- E. ENERGY CONSERVATION THROUGH MASS TRANSIT AND PARA-TRANSIT
- F. PEDESTRIAN MALLS AND AUTO RESTRICTED ZONES
- G. URBAN FREIGHT/SERVICES DELIVERY

IV. INTERCITY PASSENGER TRAVEL
- A. INTERCITY PASSENGER TRANSPORTATION ENERGY CONSERVATION ANALYSIS
- B. INTERCITY PASSENGER DEMAND MODEL - DENSE URBAN CORRIDORS
- C. AIRLINE ENERGY USE, CONSERVATION MEASURES & POLICY ALTERNATIVES
- D. AIRLINE ENERGY USE, CONSERVATION MEASURES & POLICY ALTERNATIVES (CONT'D)
- E. MODE SHIFT AWAY FROM SHORT-HAUL AIR

V. INTERCITY FREIGHT TRAFFIC
- A. ENERGY EFFICIENCY VS. PHYSICAL DISTRIBUTION EFFECTIVENESS IN INTERCITY FREIGHT
- B. ENERGY EFFICIENCY VS. PHYSICAL DISTRIBUTION EFFECTIVENESS IN INTERCITY FREIGHT (CONT'D)
- C. RAILROAD FREIGHT SERVICE IMPROVEMENT

VI. TRANSPORTATION SYSTEMS
- A. TRANSPORTATION ENERGY CONSERVATION RESEARCH NEEDS
- B. PRICE ELASTICITIES OF DEMAND FOR TRANSPORTATION FUELS
- C. COMMUNICATION AND MOTIVATIONAL RESEARCH
- D. PRICING DISTORTIONS OF PETROLEUM PRODUCTS
- E. PRICING DISTORTIONS OF PETROLEUM PRODUCTS/TRANSPORTATION FUELS (CONT'D)
- F. TRANSPORTATION AND ENERGY DEMAND FORECAST
- G. COMPARE FEDERAL POLICIES FOR ALL MODES, INCLUDING USE OF TAX REVENUES

*THE AMOUNTS WITHIN THE PARENTHESIS INDICATES THE BREAKDOWN OF FUNDS BETWEEN FEA/OTR AND THE OTHER CONTRIBUTING AGENCIES.

**ORPSS - FEA'S OFFICE OF RESEARCH PLANNING AND SYSTEMS STUDIES

Reproduced from Fraize, Willard E., Lenard, Michael and Lieb, John, Transportation Energy Conservation: A Program Plan of Policy-Oriented Research, MITRE Corportation, Federal Energy Administration, 1975, p.5.

we addressed the specific issues involving transportation energy conservation. As one example of many, before we could analyze the energy conservation impacts of policy or regulatory changes to divert intercity freight to the more energy-efficient modes, we had to look at the process by which a firm decides when, what, and how much to order, what mode to use, and why.

The actual research---both contracted and in-house---conducted by FEA proved to be useful and relevant during the last six months in the development and justification of the transportation energy conservation provisions of the President's National Energy Plan. Attachment I is a bibliography of the transportation energy conservation research published by FEA.

Turning from the recent past to the present, enough has happened in recent days, weeks, and months in the fast-moving subject of transportation energy conservation to warrant another look at policy-oriented research. Fortunately for our purposes, the Executive Committee of the Transportation Research Board has recently published a list of "The Ten Most Critical Issues in Transportation." (2) Attachment II is a summary of the committee's issue descriptions, together with my comments on their energy implications.

It is interesting to note that one of the issues pertains exclusively to energy conservation (II. Energy Efficiency in Transportation) and that four of the issue statements refer explicitly to energy conservation (I. Financing Requirements and Alternatives for Transportation Systems and Services, II. Energy Efficiency in Transportation, III. Intergovernmental Responsibility for Transportation Systems, and V. Transportation System Performance Criteria and Design Standards). Even more significantly, our nation's apparent abundance of energy together with its artificially low prices have so permeated our transportation industries that every one of the 10 issues has major energy aspects. As suggested by my comments in Attachment II, I believe that no major transportation issue now facing the nation can be adequately addressed without reference to energy conservation. In some cases, the issues are how to maximize the attainment of partially conflicting objectives when possible and how to trade them off when necessary (energy conservation, congestion reduction, air quality improvement, transportation safety, urban and rural quality of life). In other cases, the issue is how to take account of energy conservation in transportation decision-making institutions and processes (financing and pricing, energy, intergovernmental relations, maintenance and operations, regulation, land use). In still other cases, the issue is how to measure, allocate, and forecast the benefits and costs of alternative transportation energy conservation policies and programs (financing and pricing, energy, intergovernmental relations, performance criteria, regulation, air quality, safety).

In Attachment II I summarize my specific comments on policy-oriented research needs in transportation energy conservation. A few general comments are as follows:

1. Data Collection and Analysis. Our activities in research, development, demonstrations, planning, policy and program development, budgeting and evaluation are hindered by the lack of policy-relevant data on energy use and conservation in transportation. While ERDA has taken a useful and promising first step, (3) much remains to be done. In particular, we need data on the impacts of past or prospective policy changes at the margin. We need both aggregated and disaggregated data which permit intermodal comparisons.

2. Energy-efficient Use. We need more research on and demonstrations of energy-efficient use of existing transportation systems, facilities, and services. We need to experiment with low- and noncapital improvements to conserve energy, reduce congestion, improve air quality, and/or increase safety. We need research on the complementarities and tradeoffs among these goals. We need research on intermodal integration to encourage appropriate mixes of modes and vehicles to serve different market segments and to facilitate transfers between modes or vehicles. Energy conservation can serve as a driving force, bringing about desirable changes which make sense in terms of transportation efficiency as well.

3. Evaluation. We should be systematically evaluating the effects of current transportation energy conservation policies and programs (e.g., the 55 mph speed limit) to determine their benefits and costs. We should be developing evaluation designs to track emerging policies or demonstrations from the beginning. We need research on evaluative criteria for transportation energy conservation and its linkages with other national, state, metropolitan, and local goals. We need to know more about the external effects and second-order consequences of transportation policies and programs.

4. Information Dissemination. We have learned a lot more about transportation energy conservation than we use. We know more than we have disseminated. We should be explicitly incorporating what we have learned in the ongoing transportation planning and decision-making processes. We should be demonstrating what we have learned in various combinations in various types of areas. We should be developing case studies of successful efforts at various levels of sophistication to incorporate consideration of transportation energy conservation in the ongoing transportation decision-making processes and to link State Energy Conservation planning to Transportation System Management, Transportation Control Plans, comprehensive planning, and other functional planning.

Conclusion. I am aware that I have set forth an ambitious research program. I am pleased that this workshop will refine some of the research specifications and recommend priorities among researchable issues. I urge you to avoid the temptation to produce a laundry list of all imaginable research projects and recommend that you propose a focused research plan which reflects your sense of research priorities. I can think of no more appropriate organization to orchestrate this process of research specification and priority-setting than the Transportation Research Board.

TRB has done a first-rate job of orchestrating transportation research. I urge the board to take the next step: to ensure dissemination of the results of research, development, and demonstrations in transportation planning, policy and program development, budgeting and evaluation.

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The Ten Most Critical Issues in Transportation, as identified and described by the Executive Committee of the Transportation Research Board, Transportation Research News, November-December, 1976, pp. 2-4

I. Financing Requirements and Alternatives for Transportation Systems and Services
   A. Find new revenue sources
   B. Allocate costs for construction and operations
   C. Pricing of transportation services among users and nonusers
      1. needs for the disadvantaged
      2. minimum levels of service
      3. regulation of monopoly services
      4. energy
      5. environment

Author's comments on energy implications:

1. As a relatively energy-intensive service, transportation demand will be affected by increasing price and decreasing supply of energy.
2. The more energy-intensive modes will be most affected.
3. The impacts will be regressive since the poor tend to expend relatively large percentages of their incomes on energy.

Author's comments on research needs:

1. Data collection and analysis concerning transportation energy demand, supply, consumption, conservation, costs, revenues, and prices, both aggregated for society as a whole and disaggregated by income, age, race, sex, employment status, and region. Data should be sensitive to the effects of policy changes at the margin and valid for intermodal comparisons.
2. Increase understanding of external costs and benefits, second-order consequences, etc.
3. Demand for additional facilities and services to transport energy from newly exploited services or fields.

II. Energy Efficiency in Transportation
   A. Optimize use of liquid fuel energy resources in
      1. transportation construction
      2. materials manufacture
      3. vehicle operation
   B. Research should concentrate on
      1. improving the efficiency of the internal combustion engine
      2. improving vehicle design
      3. increasing efficiency in planning, design, construction, and maintenance
      4. economic interrelation of energy and transportation
      5. social and environmental effects on the populace of changes in policy

Author's comments on energy implications:

1. Optimize use of all energy sources, but especially petroleum and natural gas.

Author's comments on research needs:

1. Research on trade-offs between energy consumption now in construction and manufacture and energy conservation later in operations and maintenance.
2. Research on more energy-efficient use of transportation systems, facilities, and vehicles, including measures to overcome institutional and behavioral obstacles.

III. Intergovernmental Responsibility for Transportation Systems
   A. Roles, responsibilities, and functions of federal, state, and local governments in funding, construction, management, regulation, and control of highways, air, rail, waterways, urban transit, rural transportation, environment, land use control, and energy
   B. Clarify transportation policy, plans, and implementation
   C. Difficult, time-consuming, costly transfers from one mode to another
      1. institutional arrangements for delivering transportation services
      2. geographic, fiscal, labor, and regulatory constraints
   D. Reducing or changing travel demand
   E. Uneven distribution of costs and benefits
   F. Lead agency---whether metropolitan areas and other regions need an areawide institution to coordinate and fill service gaps
   G. Compatibility among regulatory roles of federal, state, and local governments to reduce undue complexity and prevent undue disruption
   H. Impacts of labor, work rules, and union participation

Author's comments on energy implications:

1. While energy conservation is a national goal, state, metropolitan, and local policies, plans, and programs are required to attain it.
2. Requires coordinated, cooperative, continu-

ing, comprehensive decision making involving all levels of government and all modes of transportation to:

a. improve institutional arrangements
b. overcome obstacles
c. reduce or divert demand to energy-efficient modes
d. allocate benefits and costs
e. relate transportation to land use, urban form, and urban development

Author's comments on research needs:

1. Case studies on successful efforts to integrate the modes of transportation and the levels of government so as to conserve energy and/or attain other national objectives.
2. Disseminate information on the state-of-the art in transportation planning and energy conservation.
3. Research on the linkages between the urban transportation subsystem and the broader urban system.

IV. Transportation System Maintenance Technology and Management
- A. Organizational structure for managing the U. S. transportation systems
  1. modally oriented
  2. fragmented
  3. short-term needs
  4. inefficient
- B. System is now essentially in place
- C. Institutional constraints on innovation and creativity in maintenance relative to development and building

Author's comments on energy implications:

1. Increase energy efficiency in operation and maintenance of the existing system.
2. Implement low- and noncapital measures to increase energy efficiency.
3. Devise institutional arrangements among levels of government and modes of transportation to facilitate 1. and 2. above.

Author's comments on research needs:

1. Research on effective combinations of low- and noncapital measures, including, for examples, both transit and ride-sharing incentives and single-occupant auto disincentives.

V. Transportation System Performance Criteria and Design Standards
- A. Criteria to measure the level of service of various transport modes at different levels of expenditures
- B. Effectiveness
  1. area
  2. performance
  3. service
  4. engineering and economic feasibility
  5. acceptability
- C. Performance criteria---flow characteristics of the movement of people and goods
- D. Operating characteristics
  1. time
  2. energy
  3. costs
  4. quantities
  5. origins and destinations
  6. capabilities
  7. utilizations
  8. safety
  9. continuity
  10. convenience
- E. Evaluation
  1. specification of variables
  2. acquisition of data
  3. data access through data management system
- F. Impact of risk reduction on private rights

Author's comments on energy implications:

1. Energy costs and availability impact on economic feasibility due to energy intensity of transportation.
2. Energy is significant input in construction, manufacturing, operations, and maintenance.

Author's comments on research needs:

1. Research on the benefits and costs of energy conservation measures in transportation construction, manufacturing, operations, and maintenance.
2. Research on consumer responses to changes in transportation service levels to conserve energy.

VI. Effects of Transportation Regulations
- A. Costs and benefits of economic regulation
  1. fares and rates
  2. efficiency and costs of operation
  3. rate of technological innovation
  4. level and extent of service
  5. demand
  6. profit
- B. Regulated and nonregulated carriers and cross-modal impacts
- C. Impacts of alternative types of deregulation or regulatory reform
- D. Costs and benefits of safety regulation
- E. Common carriers and private carriers and operators
- F. Impact of risk reduction on private rights

Author's comments on energy implications:

1. Consideration in regulatory processes of energy impacts.
2. Consideration of energy impacts of regulatory reform.

Author's comments on research needs:

1. Research on methods to forecast the impacts on transportation energy consumption of alternative regulatory reforms and decisions.

VII. Improvement of Existing Nonurban Transportation Facilities
- A. Optimize use of present transportation facilities
  1. scarcity of resources for capital expenditures
  2. environmental impacts
- B. Improve or maintain efficiency or productivity and safety of existing facilities, primarily in nonurban areas, with a minimum of capital expenditures
  1. acceptable solutions
  2. trade-offs between efficiency and safety
  3. balance between present capital expenditures for improvements and future operating and maintenance

costs of unimproved facilities
4. impacts on total mobility of society

Author's comments on energy implications:

1. Same as IV.

Author's comments on research needs:

1. Same as IV.

VIII. Transportation, Land Use Control, and City Forms
- A. Transportation system influences social and economic development of urban society
  1. short run: shifts in trip making
  2. long run: choices of residences and work places
- B. Systems analysis to coordinate land use, urban development, transportation, and well-being
- C. Construction has massive impacts for good or bad
- D. Urban center is mass of complex relations among people, functions, and subareas
  1. desires and needs of families and individuals
  2. mechanics of functioning of urban complexes
- E. Research in human and social sciences and urban design and living

Author's comments on energy implications:

1. Both short- and long-run changes to increase energy efficiency.

Author's comments on research needs:

1. Research on energy and other consequences of substitutes for transportation, such as telecommunications and land use changes.
2. Behavioral research on responses to energy conservation measures.

IX. Transportation and the Environment
- A. Air pollution from the automobile is a health problem
  1. design improvements and traffic restraints to reduce pollution
  2. develop inexpensive, effective clean engine
- B. Construction of new facilities
- C. Noise
  1. health and physical standards for exposure
     - a. highway construction
     - b. highway facilities in use
     - c. airports
     - d. railroads
     - e. other
  2. measure noise levels
  3. design barriers to alleviate noise

Author's comments on energy implications:

1. Design improvements and traffic constraints generally conserve energy as well as increase air quality.
2. In some cases, need trade-offs between energy conservation and air quality.

Author's comments on research needs:

1. Research on complementarities and trade-offs between energy conservation and air quality.

X. Transportation Safety
- A. Highway travel has highest accident and fatality rates
  1. safer designs
  2. safer methods of operation
- B. Other modes much better but could and should be improved

Author's comments on energy implications:

1. 55 mph speed limit has saved lives and conserved energy.
2. In other cases, need trade-offs between energy conservation and safety improvements.

Author's comments on research needs:

1. Evaluation of the energy conservation and safety benefits of the 55 mph speed limit.
2. Research on complementarities and trade-offs between energy conservation and safety.

HOW A SHIPPER SEES SOCIAL, ECONOMIC, AND ENVIRONMENTAL RESEARCH NEEDS

William K. Smith
Vice President, Transportation, General Mills, Inc.

Before I get started, why don't you all stand up for a minute. And while you are standing, I would like to ask some questions. How many of you are from state or local transportation agencies---just raise your hand. How many of you are from federal transportation agencies? How many from universities? Private consultants? None of the above? Okay.

I represent a group of people---I shouldn't say represent---I am a part of a group of people who seldom appear before this type of audience. You don't know them, and they don't know you. That is a generality, but I think it would be fairly applicable, and that is the so-called "shipper." Some people refer to the buyer of transportation services from the railroads, airlines, truck lines, whatever, as a shipper. Some people refer to us as the "users" of for-hire transportation services, regardless of the mode. Along with being users of for-hire truck lines, railroads, airlines, and so forth, many of us operate transportation systems. Most of the large barge lines are operated by private companies; they are private barge lines. Most of the domestic ships on the Great Lakes are privately owned and operated. Many of the truck fleets are private truck fleets; they are not common carrier operations. All of the railroads basically are common carriers, but there are several hundred small railroads that are owned by companies such as paper companies, steel mills, coal companies, and so forth, and some of those railroads are not very small. The Bessimer and Lake Erie, for example, is a fairly large railroad and it is one of many railroads owned by U. S. Steel. So the "shipper" or the "user" of transportation is involved in just about everything except building highways, and they do build pipelines. Many of the pipelines are private pipelines, and the company that operates them is a "shipper" or "user," as well as being a private pipeline.

There is a directory in the field that publishes the names and positions of people who have jobs such as mine. And I think in that directory there are about 11,000 companies identified, and there are about 30,000 people who have some such title as Director of Transportation or Private Truck Manager or Director of Traffic. That word "traffic" is different from the meaning that a lot of you give it, if you are in highway administration. To a highway administrator,"traffic"is an entirely different world from "traffic" in a company such as General Mills where it involves economic aspects of transportation such as the pricing of transportation.

But there are about 30,000 of my peers floating around in the country, and very, very few of them have anything to do with transportation research and development and long-range planning, other than those who are involved in the long-range planning elements of their employers. But almost none is to be found in the National Research Council or any aspect of it or in any parts of the Academy of Engineering. I am on the Executive Committee of the Transportation Research Board, and I suspect I am the first of my peers who has ever been there so we are probably a strange breed to most of you, perhaps in more ways than one. Therefore, I am going to take a few minutes to describe what "shippers" do and then get into some issues that may be of interest as future research and planning possibilities in the areas of society, economics, and environment.

One of my responsibilities is to buy transportation. I buy it from the common carrier modes of transportation---almost all modes of transportation. Sometimes, if for various reasons we do not find that the common carrier has the service or price that we are looking for, we establish our own truck line or barge line. Or sometimes we will affiliate with other companies and set up some sort of association, of which there are various types that can combine their interests and become involved in transportation services.

Our transportation procurement is not just for freight; it also is for people. This is not true of all these particular jobs, but it is still a fairly common thing to have a responsibility for the transportation of people in your company. It might be the salesman's automobile, of which there can be many thousands in some of these companies. It might be paratransit, such as the "commute van." The commute van began in Minneapolis-St. Paul at the Minnesota Mining and Manufacturing Company, and the idea was quickly copied by General Mills and Honeywell and other people in that area, and then was picked up around the rest of the country. That is a people transportation kind of thing that managers in my kind of work become involved with.

We are interested in the safety of people in transportation. It may surprise you to know that one of the more frequent things I do in my government contacts is to work with the Federal Aviation Administration on safety of commercial transportation, and not for my own hide. I am on an airplane two or three times a week, but my safety concern also is for the many thousands of other people in our company who are traveling on airplanes. And there have been times in the past when we have said you can't fly on that particular airplane or you can't fly with that airline.

We, the kind of company that I represent, are nontransportation companies as distinguished from the railroads and truck lines. Our primary business is not transportation. Our primary business is doing something else, and transportation is something we use to facilitate a nontransportation business.

There are some companies who are transportation users who also are transportation suppliers, such as General Motors. General Motors is probably the largest user---other than the federal government---of transportation in this country. I think they buy more than $2 billion a year worth of transportation services from the railroads and truck lines. And at the same time, though, they are a supplier to the carriers. Their whole business is supplying transportation except for their appliance business. They are either supplying automobiles, or they are supplying trucks, or they are supplying electro-diesel locomotives, or they are supplying turbine engines for the aircraft industry. That is a unique kind of company---in that most shippers are not major suppliers to the transportation companies. The context in which I speak to you is that of the nontransportation company buying from, rather than selling to, the transportation systems. And that context flavors my comments.

My comments also are flavored by the fact that for the last three years I have been working with an organization called the United States Railway Association, which was the planning group for restructuring the bankrupt railroads in the northeast, which set up what is called Conrail, and which is now a banker to Conrail as well as to a couple of other railroads. That flavors some of my thinking.

So with those things in my background, how do I as a shipper see some of the future research needs in social, economic, and environmental areas?

I look not so much at new things as how to make better use of the things we now have. There are major elements within the transportation system that are very, very poorly utilized, and not many elements that are well utilized. There are degrees of utilization, and when you look at something like United Parcel Service, you can put that on the high end of the spectrum on efficiency and utilization of their resources. And you can look at some elements of the railroad industry and can put them down at the other end of the spectrum on efficiency and productivity.

In how well we do things in transportation, I am going to throw out a word that you probably haven't run into too much and that is "reliability." I think the most critical factor in transportation from a freight viewpoint in this country right now is lack of reliability within many elements of the system. I am not going to get into all the details of the measures of reliability. But in generalities, to some people "reality" is being there on time. To some people it is having the vehicle available to start the cycle to be there on time. Reliability to the Association of American Railroads includes "freight car productivity." Over the last several years, the Association of American Railroads has been conducting a major research effort with substantial funds from their suppliers and from the Federal Railroad Administration in DOT. That research program is keyed into reliability.

Dr. Harris, who came from outside of the railroad industry and who now heads up the Association of American Railroads' research and test activities, did not know much about the railroads. So one of the first things he did was to find out something about the needs of the railroads' customers. His customer contacts suggested that a lack of reliability in the railroad system was the greatest weakness of the system. Harris has begun a lot of programs, with support from people outside the industry and from the federal government, which are designed to improve reliability. Improving reliability is not only the fairly obvious on-time arrival at destination of the freight car, but it ties into another word that was mentioned a moment ago---"utilization."

There is probably no asset in this country poorer utilized than the railroads' freight car investment. There are something like $15 billion in freight cars in this country, which is up about 700 percent over what it was 20 years ago. Part of that is inflation, but a large part of it is also more complex and more specialized freight cars. The approximately $15 billion invested in freight cars is about the biggest single asset element of the railroad industry. And it is a very, very poorly utilized piece of change. Until it is better utilized, the railroads (as an industry) are going to be the financial disaster that you keep reading about in the media.

So there is and must continue to be research for the railroad industry on "reliability" and on "improving utilization of the freight car."

There was a recent study made for the Association of American Railroads, which study I don't think has been released yet, on reliability. Actually the study was not of reliability; but it was a study of the literature pertaining to railroad reliability: what has been in the universities on this subject of reliability, what has been done in the institutes on reliability, and what has been done in the railroad industry itself. And thus the study's report is largely a bibliography on everything that has been published on "reliability." And from the bibliography, there is a conclusion, and I am paraphrasing---that it is almost negligent as to how little railroads know about the importance of reliability to their customers.

"Reliability" also applies to other modes of transportation---but within different performance measures. The railroads might talk about good reliability, if the shipment arrives within a day or two of a specified date. To the truck line, arrival is probably measured against the day, or it might be the hour. With Federal Express on United Parcel Service, the measure of arrival could be the hour. So you have different levels of performance measure for different modes.

The reliability of railroad transportation is jeopardized by the complexities of the "train-operations system": the track (and roadbed), the freight car, the locomotive, the train, the train crew, the geography and climate.

The railroads have known much about each of those elements of the train-operations system. But they have found that they do not know enough about the relationships and interactions between these elements.

The Association of American Railroads' Track/Train Dynamics Research Project is directed at learning more about the interactions between the elements of track, car, locomotive, train, crew, and environment. The project is being assisted by FAST, Facility for Accelerated Systems Testing, at the Federal DOT Research Center in Pueblo, Colorado.

The FAST program includes the operation of a freight train hundreds of miles each day, in a controlled situation, using a variety of track and freight car components.

In one year they will duplicate 10 years of very high level usage, and this is in many respects similar to the highway tests in Maryland, Illinois, Idaho during the 40's and 50's and the early 60's. The railroads are quantifying like the highway builders a couple of decades back, what is going on inside of that roadbed, those ties, and that steel. Again the research is tied into reliability; it is tied into safety; and it is tied into economics. And shippers, if they have any interest in research and development and use the railroads, are pushing those programs very heavily because we are interested in such things as keeping the train on the track. We are interested in avoiding paying for the trains that go off the track. We pay for such accidents in our freight rate.

Our company has a plant in Lodi, California, which is a fairly large plant, and it has shipped a lot of business over the Southern Pacific Railroad. In a year, we will pay the Southern Pacific about $3 million for rail services to and from that plant, a major piece of money. That also is big income to the Southern Pacific. A year ago, in one Southern Pacific freight train derailment (it didn't involve any of our freight) a train with almost new locomotives, with freight cars all of one kind (mechanically refrigerated cars), on beautiful track (some of the best maintained track in this country) with about 80 or 90 cars in the train, most of them ended up in the ditch, and there was something like $2 1/2 million damage to the train and the roadway, and God knows what the damage was to the merchandise. That derailment cost that railroad as much as (if not more than) we paid the railroad for one year's services at a major shipping facility. And it was a derailment with "suspected" but not conclusively identified cause. The railroad is going to get the cost of the derailment back from everybody that uses that railroad, and we can't afford any railroad having those kinds of accidents, so we are very much interested in research programs directed at identifying and preventing whatever cuased such "mysterious" derailment.

As a shipper and user of transportation, I am very much concerned about the lack of good data in transportation. I am very much concerned about the lack of good costing techniques in transportation. Improvements are being made---Congress has passed legislation which requires the Interstate Commerce Commission, for example, to improve its costing techniques, which techniques have been part of the problem. I am not certain that sufficient improvement is going to come forth, but at least an effort is being made. Transportation Research Board---or the National Research Council---recently held a meeting in Washington on transportation data: what is needed; how do you get it; how do you maintain it?

When you get down to the decision making that I have to make and my peers have to make; when you get down to some of the decision making that Congress has to make on "railroad versus truck" issues pertaining to the allocation of federal money to the transportation system, the data is almost irrelevant, and it is not timely.

Studies that have been made by the highway departments gathering up data on what goes from A to B is too gross, and it is almost of no use to the kinds of questions that are before the shipper, before the common carrier truck line, and before the ICC. "Data" (availability, storage, retrieval, timeliness, etc.) is an area for research.

I am very much worried about the maintenance of the transportation infrastructures we have in this country. One of the previous speakers referred to the fact that we built the system. We have the legs from A to B to C, and I agree. But there are parts of it rapidly wearing out, and even if the Federal Highway Administration is wrong, or the Minnesota Department of Transportation is wrong on some of their estimates of needed maintenance and rebuilding, even if they are only half right, or only one-third right, I am very much concerned about the seriousness of the deterioration of the highways and railways. My concern comes from my recent experience with the railroad in the northeast. For years I have prided myself on being better informed than most of my peers, but I completely overlooked, during the 1950's and 1960's, a fact that I had thrown at me in 1974

when I was put on my railroad job at the United States Railway Association. This is not a very glamorous subject, but it is pretty basic. Up until 1955 the railroads---and I am talking about railroad ties which are comparable to concrete in the highways and the surface under the concrete---up until about 1955 railroads had been putting 50 million new ties a year into the railroad system. Then the replacement rate started to go down, and it got down to about 15 to 20 million through almost 20 years, and I didn't pay any attention to that, and I don't think many others paid any attention to it. Now the tie replacement rate is going back up. It is up to 20 or 25 million ties a year, but the basic physical foundation of the railroad system, the ties, except for some railroads, has gone to rot. And now it is going to be replaced with 1977 prices, in which ties cost $12, $14 apiece, and if they had be been properly replaced during all of those years, there wouldn't be so many to replace at today's inflated prices.

I think the same invisibility is happening in the highways and the bridges. In Minnesota, our highway department said we should spend $100 million a year for the next 10 years just to repair bridges. The legislature gave them $50 million. I believe it would be absolutely criminal if the physical condition of our highway system ends up the same way the railroads did. Remember that almost no one that I can recall during 1960, 1965, 1970, 1975, was really saying---look at railroad tie maintenance; they are not putting 50 million ties a year in, they are down to 15 million per year. You can probably defer that maintenance for a few years and it doesn't make much difference, but it happened for 20 years with the railroads. Is it also now happening with the highways?

There are a couple of books that I think you ought to get hold of, because as a shipper I think they contain more information on future transportation research than most other publications. One is a Transportation Research Board book of about two years ago that publishes all the papers at a Woods Hole conference in 1975. (Railroad Research Study, Background Papers, July 1965) There is a summary that is coming out, a condensation rewrite of all those papers. I think you ought to get ahold of the original book, the papers that were presented. It is oriented mostly to railroads but there are chapters on trucks and barges and economics, you name it, all subjects that relate to transportation. The bankers are talking about financing, labor is talking about labor, the professors are talking about education. It is all in there, and I think you ought to have that book.

Another book (that you probably can't get) pertaining to future transportation research is National Transportation Trends and Choices which the Democratic Administration doesn't like. They have banned this January 1977 Federal DOT book, but there are a few copies around. This book is not the end result, but it is a good first step to what might ahve been a fairly broad base planning effort in this country on transportation, but you can't get it right now.

So the shipper in transportation is very, very much interested in research programs oriented toward improving reliability of transportation modes which, in turn, permits improving the utilization of the modes, which in turn is better productivity, which in turn may help us not pay quite so much money, or give us a better transportation result, a better payback from transportation. And I think we recognize that data and costing weaknesses in this area are going to be detrimental to some of the decision making on what do we research and develop. And finally, you all have a Transportation Research Board handout called the Ten Most Critical Issues in Transportation. (The Ten Most Critical Issues in Transportation are discussed in Carl Rappaport's paper in this circular.) I worked pretty hard on this one. There is a lot of stuff in here that I put in as a shipper. So if you want the broad brush thing on what one shipper thinks, there is a lot of it here, which is an Executive Committee publication. Thank you.

SOME SOCIAL, ECONOMIC, AND ENVIRONMENTAL RESEARCH NEEDS

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I would like to just raise a couple of propositions with the hope of opening a conversation with you about them. It is my thesis that we are at a turning point in the history of transportation developments in these decades. And I think we can identify at least four major shifts that seem to be long-term in character and that are probably going to be shaping our research and policy agendas through the 1980's. Let me just enumerate those four and then make a few comments about each of them.

First, despite the backlog in highway developments we have been hearing about, I think that job is nearly done. After a century-long effort to bridge this continent, we have now nearly finished the job. The big civil engineering projects to build initially a rail network and then a road network across the country has now connected every place to every other place, or nearly so. And so, having completed that job, we are now groping for ways of making that transportation network work better. Engineering styles of design and construction are having to be supplemented by other styles, and so we are seeing the introduction of new kinds of people into the transportation planning and management business---economists, lawyers, environmentalists, and sociologists, peculiar types.

Second, the concern for efficiency, which has dominated the transportation planning and management business for so long, is now being supplemented by a concern for equity. And we have been hearing some of the echoes of that in these last two comments.

Third, the powerful role that transport has always played in shaping land use patterns and in locating cities may now be ending. I will have more to say about that in a moment.

And fourth, the decline in public transit services is leaving a large gap, and we don't know quite how to fill it. We have been groping to find a successor to the old public transit systems, and we haven't known where it is. For awhile,we thought the successor was likely to be rail rapid transit systems, and so far at least the experiences in San Francisco and Washington are not encouraging. For awhile we thought it was going to be personal rapid transit (PRT) and/or dual mode. Now it looks as though PRT and dual mode are somewhere down the line sometime later. Some of us are optimistic about the prospects for paratransit, particularly for using automobiles as public transit vehicles, and some experiments are underway in those realms, as you know. Others are optimistic that pricing

systems of various kinds might be a way to better manage the system, and a little experimentation is going on there, but I think the Singapore experience is the most notable.

There is no obvious successor to transit, and it looks as though the old forms, the pre-automobile forms, are not working very well either. So in respect to all four of these developments, we seem not to have answers, and we are obviously groping---sometimes intelligently. Let me elaborate on these themes briefly.

During the 1950's and then into the 1960's, the transportation planning task, particularly the urban transportation planning task, got fixed into something of a formula. You all know it well because you have all been practitioners of it. This task was to predict population and employment, predict land use patterns or lay out desired land use patterns, generate traffic, assign it to a network, and then build the roads that would carry the expected demand. And then, faced with the backlog of highway construction, we undertook the job to put those roads in place, connecting suburbs to their center cities, connecting metropolitan areas to each other. And that, as I said before, calls for civil engineering knowledge and public works construction skills.

Essentially, the key to the transportation planning task of that time was predicting latent demand and then building facilities that would satisfy it. That task, I am suggesting, is nearly done. Virtually every spot on the continent is now connected to every other spot by roads and airways. In turn, we have built a tremendous fleet of vehicles to operate on those roadways and equipped the population with cars and driving skills. Unfortunately not quite all, everyone in the population is so equipped, but those who do have highways, automobiles, and driving skills are being very well served. Americans enjoy levels of accessibility that are unprecedented, and they enjoy degrees of personal freedom that are unmatched elsewhere.

And yet, now that we have just about completed the job of linking everyone or every place at least, we seem to be unhappy about that. A vocal new lobby has arisen which is overtly anti-automobile. Initially there was a wave of conern in the late 1960's about high accident rates on the highways and a concern for vehicle safety. That spread over the continent and into the Congress, and we have now been doing something about that. Within the past few years, the nation has become concerned about the cumulative environmental effects of automobile use and highway construction, and we have been hearing about that, particularly of course, about air pollution. Others, more recently when it has become fashionable, have been concerned about energy consumption. We will be hearing more about that one, no doubt. Still others are concerned about the fact that automobility has, in fact, meant the decline of the public transit services. Others, I suspect, have joined the anti-auto crusade for the same reasons that have already encouraged people to join crusades. With a strange perversity, because the automobile highway system has become the mass transportation system, it has come under attack in the name of mass transportation.

These recent criticisms have already generated a wave of engineering changes that are surely going to improve the auto highway system appreciably. Both the roadways and the vehicles are being considerably improved, and they are far safer than they were before, and certainly more changes are forthcoming in vehicle design. Fuel efficiency is being improved dramatically and will continue to be. Exhaust emissions are being cut even more dramatically and some knowledgeable engineers are predicting that the air pollution problem produced by automobiles will be gone in 10 years, or rather as soon as we can replace the fleet, so it may be a little bit longer. But it is a solvable problem. In a sense, these three problems, safety, fuel, and emissions, have yielded to straightforward regulation and to engineering techniques.

But some other problems remain, and they are far more intransigent. The most serious of these problems, I believe, is that the accessibility afforded by automobiles is not available to everyone. That those who remain carless, either because they can't afford cars or because they can't drive them, have been positively hurt by the rise of the highway auto system, just as others have been positively helped. That seems to me to be our major dilemma.

Insofar as cars have induced a decline in public transit service and a reorganization of metropolitan spatial structure, they have also constrained life opportunities for those who are poor and/or black, or for those who, because of age or infirmity, cannot drive. It strikes me that the major, perhaps the only fundamental problem of the auto highway system, lies here in its equity effects, that everyone does not have the equivalent of auto-like accessibility. I suggest that the proper response to that persistent problem is not to ban the car, or to put additional constraints on its use, or to stop highway construction. Rather it is to invent additional means of supplying transport services to those who are carless so that they can enjoy equivalent accessibility.

There has been a lot of discussion of some of the potential means---I mentioned a few. Perhaps one of the more optimistic ones is more effective use of transit services---the old sort, but somehow modified, as, for example, using the old bus in express mode, perhaps with exclusive right of way, or perhaps with preferential treatment. There is a lot of experimentation around the world in that respect.

Small vehicle transit services of various kinds are prospects, and paratransit modes using automobiles as public transit vehicles seem to me to be among the more likely prospects. Perhaps some of the new vehicle types of the Morgantown sort (personal rapid transit) or its successors hold promise. Perhaps it is more equitable taxing and subsidy arrangements that assign the costs more fairly than has been our habit. Perhaps charging full costs of transportation services to all users---automobile users and transit users---is the right way. We have tended to try to use transport services as a medium for income redistribution, and that is a pretty inefficient way to redistribute income. I would suggest that we ought to be exploring the prospects of charging everybody what it really costs. And then if we seek to supplement incomes, that we do so via the income tax. That would solve many of your financing problems, incidentally.

I would like to see some further exploration in new organizational forms for redistributing services, for organizing the industry to make it easier for people to use automobiles and transit services of various kinds and thereby perhaps also inducing some innovation in pricing.

Now let me say just a few things about the effect the automobile has been having on land use patterns. It has been charged, as you know, with having created the low-density suburbs, for having induced central city decline, and for having encouraged sprawled metropolitan development patterns. Those who prefer high densities and traditional city forms have in turn condemned roads and automobiles

because they have been so effective. Their condemnation has been so enthusiastic that they have succeeded in stopping many of the highway construction projects around the country, as we have been hearing here. But if that is their purpose---somehow to shape land use patterns---I think their efforts are too late.

I am guessing that we have now passed the historic threshhold and that for the first time in all history transport is no longer the determinant of land use patterns. It is true that highways have traditionally opened metropolitan hinterlands to suburban development. It is true that earlier the railroads opened up the west and indeed located the cities of the west, placing them at railheads or rail junctions. It is true that earlier than that the canals, the sea ports, and the crossroads did the same. But those days are passed. Now that every place is directly connected by roadway to every place, now that most industries are locationally freed from their natural resource sites, now that knowledge is the major input to industrial development and industrial processes and not raw materials, now that most industries and most households are footloose, they can locate anywhere. We now enjoy locational freedoms that are unprecedented. Each metropolitan area is now so internally well served by a ubiquitous network of roads that any additional improvements to accessibility are unlikely to make much difference. (That is the main reason, I am guessing, why BART has had so little effect on land use patterns in the San Francisco area.) It looks as though it is now too late to shape land use patterns deliberately through installation of transport systems.

So, even though the highway auto system has induced suburban sprawl and metropolitan spatial reorganization to low density patterns, it is too late to use transport to change that. Moreover, I think, those who are unhappy with that pattern are stuck with it. I think we have had an irreversible history working here, inducing lower and lower densities, and we can't go back. American cities are low density and they are likely to remain so whether we like it or not. That has some implications, to be sure, for fuel consumption. People are going to be traveling long distances in this country, longer than elsewhere. And although some of the critics have been hoping that the rise in gasoline prices would induce a reduction in auto use and then an increase in density, my guess is that they are going to be disappointed, because the demands for auto use are so inelastic with respect to price---people are willing to pay very high prices. If you doubt that, look at the experience of other countries where gasoline is now up over $2 per gallon and where per capita incomes are far lower than those in the United State. Even so, automobile ownership and use curves are rising---in Japan, Brazil, France, for example.

And then, by the time prices get high enough to make much difference---say, on the order of $5 or $10 a gallon; I don't know how high it has to go to make a difference in people's use patterns---by that time, we are likely to have a workable electric automobile. I understand the industry is really being very optimistic about new battery developments, and they are talking about producing electric powered cars within a few years. If they succeed, that fear will be mitigated.

Some have predicted that we are going to be developing old-fashioned city centers again, because they are expecting that rising fuel prices and demographic shifts are going to be moving the middle class back to the central city. Bill Alonso's scenerio reinforces that view. He notes that the number of childless households is increasing very dramatically. In fact, the number of households with only adults, whether married or unmarried or all male or all female or mixed, is increasing. Female labor force participation rates are rising far faster than anybody ever predicted. With two or three or four adults working, a center city location is far more amenable than a distant suburban location for job finding and commuting. That might induce moving back. So, too, would childlessness induce moving back. That might happen to some appreciable degree, but not enough to make an overall dramatic change in metropolitan spatial structure, I am guessing.

One byproduct of that potential scenario would be that middle class folks might then be pushing poor blacks out the central city, and the next liberal war may be to save the central city for the poor. But if they do move out to the suburbs, and if birth rates among the poor remain at their high levels, we will have simply a shift in racial composition and a similar spatial structure with perhaps those suburban schools put back in business again.

With that, I am guessing that we are at a crossroads in this period in 1970's and then into the 1980's. We are groping for a style of transport planning which we have not yet found. A style that is not oriented to road building per se, whether highways or transit guideways. A style that is sensitive to the distribution of benefits and burdens among different population groups that are affected by transport developments. A style that can exploit the new technologies and can develop new styles of regulation which are less constraining, that open opportunity, that induce change rather than constrain change. And above all, a style that seeks to increase accessibility, to extend personal freedom, and especially for those for whom the automobile has tended to reduce accessibility and freedom.

Selected Questions and Responses

QUESTION: (Concerning W. Bulley's reference to a mediator to resolve disagreements among agencies.) What was the background of your mediator---was he a lawyer or what?

BULLEY: He was a professional mediator. He had been involved in many areas. He had been involved in mediation between environmentalists and developers in Seattle. He has done some work in labor negotiations.

QUESTION: Was he a lawyer?

BULLEY: No, he was not. He has his doctorate in public administration. He is not an attorney. And it is probably just as well in this case that he was not.

QUESTION: What is the state (Washington) doing to monitor the effectiveness of its laws, rules, and regulations?

BULLEY: We do that. We have a state environmental policy act within the state of Washington. We have a shoreline management act, and we do report to the legislature on that periodically and to their staffs during the interim. And they hold meetings; they hold interim sessions for us to report to them. We evaluate the cost, reevaluate the effectiveness, and we are doing that on a periodic basis. And they are receptive to change. For example, we actually had two environmental policy acts. One related entirely to highways and one related to NEPA. But there were some technical differences, so we were trying to comply with both. We got them to repeal the one relating to highways because, basically, the NEPA type legislation covered the intent.

QUESTION: (Concerning city centers losing consumer services.)

M. WEBBER: It is certainly happening already. So many of the consumer services have followed the customers out to the suburbs---doctors and dentists and lawyers. A tremendous number of business services have moved out to the suburbs of every big metropolitan area, and most notably of course, in a place like Los Angeles where they are spread around although not homogenously. They tend to localize in clusters, but not all of them. I think clearly the pattern that has been emerging since the war is dispersed, poly-nucleated---sometimes with localized clusters of a single industry. And that kind of locational freedom is now possible where it did not use to be. Where it is possible, it will happen because there are amenities that go along with it. I think it is going to continue.

QUESTION: (Concerning poor families moving from city centers to the suburbs to find jobs.)

WEBBER: Right, and that might be a motivation for them. But at the same time, it is not clear to me whether it is advantageous for present center city poor families to move out or not. There has been a large campaign to open the suburbs to poor and to the blacks, particularly because both of those groups have had barriers. Because so many jobs have been suburbanized and transit systems don't work well from center cities to suburbs. And it would seem that for some people who can get a job in the suburbs that would be advantageous. But on the other hand, center city location is an advantageous position for a person of low skill---there are lots of service jobs there. And I am not sure which is the right answer, except to open it up and let them make their own choices.

CALVIN GRAYSON (Session Moderator): Thank you very much, Mel (M. Webber). All of you know what Will Rogers said we could do about the congestion in our core areas and in the large population areas. It seemed such a simple statement then and yet it carried a lot of merit, I guess---if we want to get rid of the congestion during peak hours, we just remove all the cars that have not been paid for.

In Kentucky, as I meet with our urbanized area representatives, a very simple objective, when they are griping about their transport systems, is to say to them---put two people in a car. Isn't it a simple objective? Only two people in a car during peak hours can take care of most of the pollution and can take care of most of the congestion, and yet, I guess the whole thing is the attitudinal or lifestyle change that we really want to have.

I would also like to comment on transportation planning as it relates to system planning on a statewide basis. It is utterly ridiculous to have to go to four places in Washington to get planning funds on how to move people and goods. This speaks to the matter that Carl Rappaport was talking about--data collection and analysis. You have four different places to get planning money, four different places to get research money really. And therefore, you have no compatibility with with data. You don't have any analysis as it relates to system planning at the state level at all. I hope I have made some kind of impression on Secretary Adams. It may not rid ourselves of duplication, but it sure would help, I think, if we just said---here are transportation planning and research funds to determine in your state how to move people and goods, either in the planning phase or research phase.

BULLEY: I wish I knew an answer to that because we are involved in this communication program in our state for research which I find to be quite effective. When I want to know if something is being done, there is suddenly an examination made, supposedly of all the reported research. Then I find out later on maybe that someone is doing something in that field but hasn't reported it.

WEBBER: My biases run the other way. I am delighted that there is redundancy in the airplanes I fly. And I am delighted that there is redundancy in the research community, too, so that somebody reports a finding and somebody else reports an opposite finding. Two years ago there was a big rhubarb in one of the congressional committees. Some congressmen got upset because both the National Oceanic and Atmospheric Administration and the U. S. Geological Survey were doing research on the earthquake problem in California, and they thought that duplication was wasteful. Actually, it was only $30,000. But I was delighted, as a resident in that area.

W. K. SMITH: I lean a little bit towards what Mel Webber was saying. I am not as concerned about some of the redundancy as perhaps knowing about the redundancy.

QUESTION: Mr. Smith highlighted a problem that I have as a TRB committee chairman and that is the nonrepresentation of the user groups. Why can't we get your feedback?

SMITH: I think it is ignorance on both sides. Part of the problem is that TRB was the Highway Research Board, and as a Highway Research Board, it was a different spectrum. Most of my peers are not interested in soil stabilization, et cetera. They are becoming interested in some of the less engineering things that are now being looked at by Transportation Research Board, so we have a new door. And I think with the present door you can attract shippers. Transportation Research Board ought to have some significant people from the shipper community, not just their director of transportation. It can be only a matter of going out and asking, and that has not been done.

Try to increase TRB's funding base. TRB works on a three-year budget, and they are putting together the budget for the year beginning 1978, and there is going to be an approach made to the Ford Motor Company and Bethlehem Steel and others. (I think Bethlehem now has a membership in TRB.) There are a lot of companies that don't participate in TRB activities because they have never been asked. And when that approach is made, I think you will open up the door to get some of those people that you ought to have on the Transportation Research Board Executive Committee.

QUESTION: I would like to ask Mr. Smith about the federal versus private relationship in the rail system---the concept of nationalizing the roadbed, and at the same time, making the traffic system on those roadbeds more competitive.

SMITH: I oppose nationalization of the roadbed because I don't think it solves anything, other than some quick money going into rehabilitation of the system. The idea behind that proposal is to have the railroads the same as the highways---which are owned by the government and are publicly used. There is some shipper support for the proposal but not a lot. Basically, I don't think the proposal solves anything. I think there are other ways of solving the railroads' financial problems. For example, taxes. If you federalize that roadway, you are going to give up the local taxes anyway, so why not give up the local taxes on privately owned roadway. Frankly, I don't believe you have to do that for most of the railroad system in the country, other than some elements out in the midwest and perhaps some elements in the northeast. Senator Kennedy now has a very elaborate bill on that subject before the Senate which would do what you are describing on a voluntary basis, and railroads could put themselves into that kind of thing; it would not be mandatory. Kennedy's bill proposes a very long-term, several year, detailed planning of what is needed, what is essential, what goes in, how it is handled, in a fairly intelligent way of doing it. But I oppose the concept because I don't think it solves the railroads' financial problems.

C. RAPPAPORT: I would like to add to that. It seems to me that we need to get away from these kinds of hard and fast dichotomies between private and public. We need some more creative and innovative approaches, and I think we have made some progress in that regard. It seems to me there is a real, substantial, attitudinal, and political problem involved in the transportation industry in that there is public and congressional resistance against giving public monies to private institutions. So it seems to me what we need to do is think about other ways of solving the problem, and not just pouring money into roadbed acquisition.

QUESTION: (To Carl Rappaport concerning his reference to the Morgantown Personal Rapid Transit (PRT) system.) If Carl could comment on the local mass transit system, the Morgantown PRT was a political decision.

RAPPAPORT: I know that, and as a matter of fact, I do refer specifically to political considerations and obstacles.

QUESTION: Please summarize the federal government's current research and development in transportation energy conservation technology.

RAPPAPORT: As far as technological research is concerned, that has been assigned pretty much to the Energy Research and Development Administration (ERDA). Our work has tended to be much more on the institutional side of the question. There has been some work done also by the Environmental Protection Agency and the Department of Transportation which obviously have other kinds of specific interests in energy conservation, particularly as they relate to other goals. I have had some opportunity, though, to look at what ERDA in particular is doing in anticipation of the creation of the new Department of Energy. Basically, most of the research at the moment on the technological side has been directed at the issue of more fuel-efficient, cleaner engines. There is a lot of money being spent on that. There is a fair amount of money being spent on new kinds of vehicles---electric and hybrid vehicles. Those are the major elements of research at the moment.

QUESTION: (To L. Irwin, apparently by W. Vickery.) I found (your remarks) very challenging... but I would like to raise some questions as to what optimization really consists of. You spoke of large proportions of the highway system being either obsolete or inadequate. My impression is that these criteria are developed out of somebody's head without any really serious cost-benefit analysis to show whether an improvement of the particular structure or facility would be valid in the long run. I hold no brief for the validity of cost-benefit analysis as it has been conducted in the past, and certainly the history of it has been scattered with examples of the most shoddy kind of economic analysis ever seen, but not usually so much in highways as in waterways. But I am wondering whether one is justified in bandying about these figures of so many miles, so many bridges, so much of this or that is inadequate on the basis of standards that, after all, are perhaps themselves open to serious question.

This has to do also with the question of economies of scale, consolidation of jurisdiction. I was at a meeting a couple of days ago where it was noted that New York, having one of the largest school systems under one administration in the country, also has an administrative overhead that is about twice that which prevails in the rest of the country with no apparent increase in the quality of New York schools. And I am wondering whether you don't get into some of that if you try and consolidate highway construction in larger and larger units. In particular once you have it into a large statewide unit, aren't you aggravating the very difficulty that you spoke about in saying that after all, one shouldn't apply the standards to a local road that one applies to an arterial. But isn't this just a tendency of the large unit to want to blanket the entire property under its jurisdiction with uniform standards overall to the detriment of the economy that comes from adapting the standards of the local roads to the local needs and local desires.

IRWIN: I think we could take the whole afternoon just the two of us talking. Let me take them in order. First you asked about the validity of establishing that 82 percent of the rural roads in

the United States are deficient, based on some arbitrary standards. Indeed, those standards are extremely arbitrary. I think we could get even more fundamental and get down to how were these terms defined. In a way, I think it is rather ludicrous. There is no question about identifying an unpaved road. That one we don't have to take issue with. But the question of the low load-bearing roads---in fact, many of these roads have up to 6 inches of bituminous material on them. But it happens that in the federal scheme of things, the Federal Highway Administration has established that roads that are built with a cold-mix surface rather than an asphalt concrete surface are lumped into one of several different categories---those that have stabilization have been put into the same categories and they all come over on one side of the page in Highway Statistics. And you can draw a line down the middle of the page and by federal definition everything on this side of the line is of low load-bearing capability, and the Portland Cement Concrete and the high type asphalt concrete is over here on the other side of the page called high load-bearing capacity. There are a lot of roads in the United States, and an extremely large mileage of them, probably upwards of 50,000 miles in New York State, that have a very good quality granular aggregate base with a thin seal coat on top of them that would be described as being structurally inadequate. Maybe they are. But right now the categorization of low load-bearing capacity is not based on any actual test of strength.

This point is central to the problem of rural transportation. On the one hand, we had overbuilt the railroad system and we want to retrench on that. We need to abandon some lines. The consequences, however, are that due to the presence of the railroads, certain industries and certain businesses and certain farmers have come to depend upon the availability and the economies of rail service. By virtue of abandonment of the railroad service, we are going to have to use the highways more often. Rather than using the small farm truck, there is a trend to go into the bigger truck as railroads are abandoned. If we increase the size and frequency of the load, can the bridges and the surface of the roads take that increased load? That is the question. I am not really drawing any conclusions about it; I am simply suggesting to you, in helping to identify research needs, that this is the big question.

But more fundamentally, I for one can see at least one way that we could do a much better job of evaluating the structural adequacy of a road than by measuring how thick the surface is. Six inches of surface in Arizona is going to be far superior with the same material than 6 inches in Minnesota or New York because of the difference in environment and so on. And the FHWA cannot describe them all as being of equal structural capacity, as is presently done in Highway Statistics.

The second item you mentioned was economies of scale, and I think that is a very fundamental question. Is bigger necessarily better? And again, I wasn't drawing any conclusions in throwing out to you the fact that there is a need to evaluate this. But consider this. We can operate in California, which is 50 percent bigger in land area than New York State, but which has roughly 10 percent of the highway agencies that we do in New York. Both states serve nearly the same number of people and have roughly the same mileage of roads. This suggests that there are some things that are worthy of looking at. And I don't want to draw any conclusions other than to suggest that it needs to be looked at.

You asked a question about design standards---should we be applying design standards to the most rural road---the same standards as those for higher trafficked arterials. And that again is a question that I feel needs research, and again I am not trying to draw any conclusions or point directions. Perhaps I biased my opinion---you could see that my opinion was kind of showing through, the way I phrased it. I personally believe that we cannot justify the higher design standards for the low-volume road, but I feel this is an area that requires a great deal of study. In the socio-economic area, I think investigations of public attitudes---what do the people really want---is a very critical point here, because we are going along with the assumption---and you pointed out the fact that---large agencies tend to want to spread the same standard over all roads. We are going along with this from the standpoint that the public wants and is willing to pay for these higher design standards. But the local people at the local level are having to pay the property taxes that build these local roads. And many of them are becoming inclined to say "nuts" to federal aid where their local share is going to finance excessively high design standards. They don't want them.

Finally, I think one of the most significant things here with regard to the question of design standards being applied to rural roads is the fact that the agencies that are promulgating these standards by and large have no direct financial responsibility for the roads, other than perhaps through federal off-system cost-sharing in recent years. The agencies are AASHTO and the Federal Highway Administration. And what the Federal Highway Administration calls a secondary road where I come from is the primary road in a county. The local feeder roads are just orders of magnitude of lesser quality than what the federal secondary road system requires. But the point is that the agencies don't have a sensitivity to this, and I think we need to identify and show them what the problem is, through research.

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