

FHWA

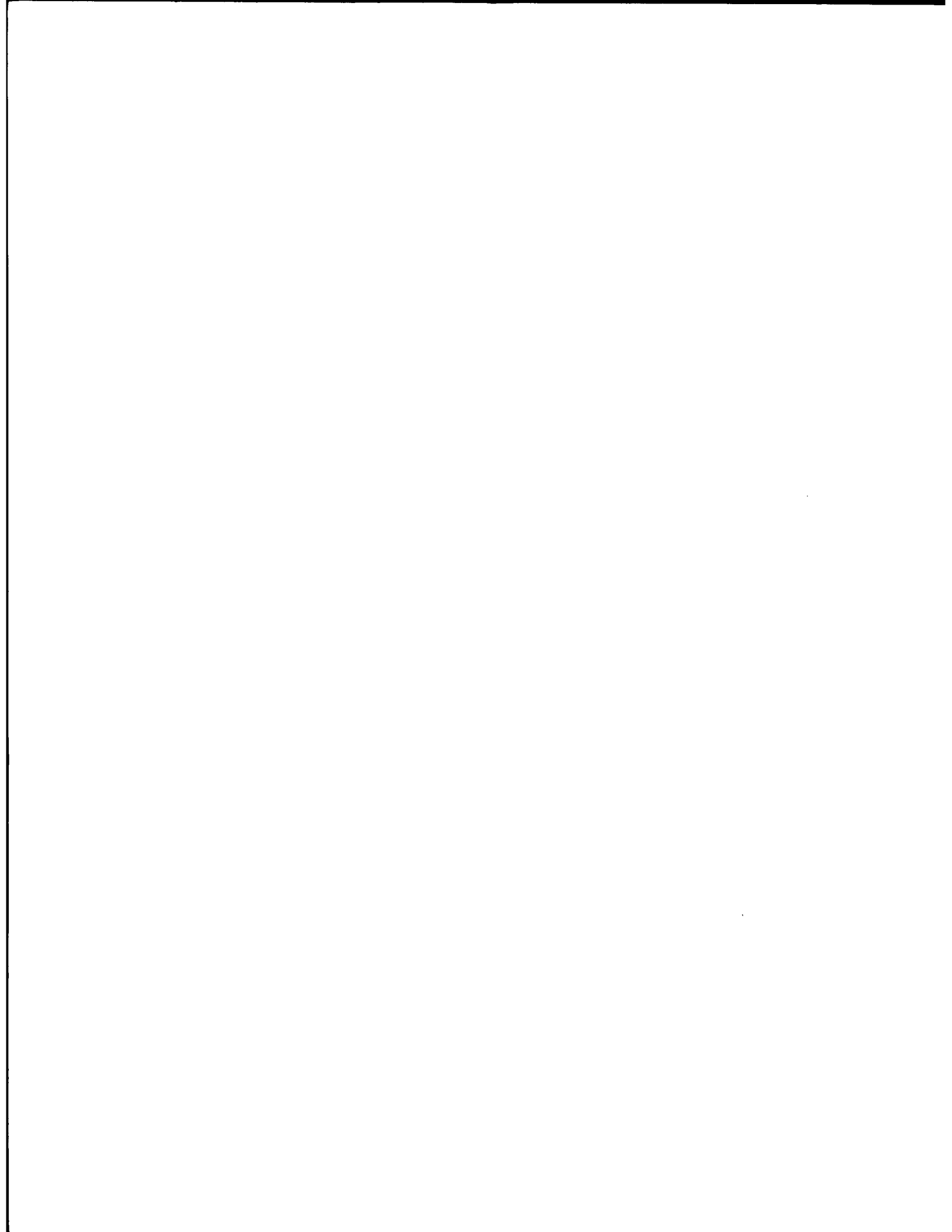
S.C.R.T.D. LIBRARY

U.S. DEPARTMENT OF  
TRANSPORTATION  
FEDERAL HIGHWAY  
ADMINISTRATION  
OFFICE OF ENVIRONMENTAL  
POLICY  
OFFICE OF HIGHWAY  
PLANNING

ENERGY IMPACTS ENERGY IMPACTS ENERGY IMPACTS ENERGY IMPACTS  
OF PROPOSED OF PROPOSED OF PROPOSED OF PROPOSED OF PROPOSED  
TRANSPORTATION TRANSPORTATION TRANSPORTATION TRANSPORTATION  
PLANS AND PLANS AND PLANS AND PLANS AND PLANS AND PLANS AND  
PROJECTS PROJECTS PROJECTS PROJECTS PROJECTS PROJECTS PROJECTS

TJ  
163.5  
.E49

PROCEEDINGS OF A PANEL  
DISCUSSION  
OCTOBER 23, 1979



**RECEIVED**

**MAY 23 1980**

**LIBRARY**

**Proceedings  
of a Panel Discussion on  
the Energy Impacts of  
Proposed Transportation  
Plans and Projects**

**U.S. DEPARTMENT OF TRANSPORTATION  
U.S. Federal Highway Administration  
Office of Environmental Policy  
Office of Highway Planning  
Washington, D.C.**

**October 23, 1979**

02646

TJ  
163.5  
.E49

## Foreword

Energy supplies and prices have been recognized as an important international problem ever since the Arab oil embargo of 1973-1974. In the United States, efforts are underway to increase both domestic production and the level of conservation to ensure adequate fuel supplies for current and future needs. Yet, this country continues to be critically dependent on foreign petroleum suppliers, some of whom may be unwilling or unable to continue meeting this country's petroleum demands.

Transportation has been looked upon as one area where considerable conservation could be achieved because as much as 40 percent of all energy consumed in this country is used to move people and goods. Increasingly, transportation agencies at all levels of government are recognizing their need to participate in conservation efforts.

As the emphasis on energy conservation has increased, so too has the number of questions that have been raised by concerned transportation officials. Whether or not energy shortages are real and will continue are questions raised quite frequently. Many transportation officials also wonder about the prospects for technological

innovation, such as the development of more efficient vehicles or new propulsion systems and fuels, that might reduce our reliance on petroleum. Others ask whether transportation projects can play a meaningful role in efforts to conserve and, if so, which transportation alternatives are most beneficial. Also, questions often arise regarding the techniques available to evaluate alternatives on the basis of their energy impacts.

To bring together available information needed to respond to these and similar questions, the Federal Highway Administration's (FHWA's) Office of Environmental Policy and Office of Highway Planning sponsored a panel discussion on October 23, 1979. The panel consisted of 11 persons, representing diverse viewpoints, who have specialized expertise in transportation and energy. They came from Federal, State, and local transportation agencies, Federal and State energy offices, consultant firms, and a university, where they are involved in the planning, research, project development, and construction aspects of transportation and energy. Mr. Michael Lash, Director of FHWA's Office of Environmental Policy, moderated the discussion.

These proceedings constitute an edited transcript of the panel's discussion. Changes have been made to produce a more concise and readable document, and to ensure a logical flow of ideas. However, the substance of all significant points raised and the overall informality of the discussion have been maintained. The material contained herein should be useful to anyone concerned with transportation and energy, indeed with the future mobility of all Americans. It is hoped that this report will help promote an exchange of ideas among all those with an interest in this important and timely subject.

A number of people should be recognized for their contribution to the success of this project. Most helpful, of course, were the participants themselves, who not only gave of their time but also offered ideas and encouragement. The discussion was initiated and organized by Michael Lash, who was assisted by Don Emerson. The transcript was edited by Don Emerson with help from Jim Walls and Tracy Daugherty, all of FHWA. Other assistance was provided by Harry Bridges and Jackie Maxwell of FHWA and by Steve Blake and Marylou Damon of the Transportation Research Board.

Comments on any aspects of this project are welcome.

Office of Environmental Policy  
Office of Highway Planning  
Federal Highway Administration  
400 7th Street SW.  
Washington, D.C. 20590



## The Participants

### DR. CARMEN DIFIGLIO

Dr. Difiglio is an Economist in the U.S. Department of Energy's Office of Conservation Policy and Evaluation. While with DOE (and its predecessor, the Federal Energy Administration), Dr. Difiglio has served as a liaison between DOE and transportation professionals. His DOE activities have included the analysis of transportation conservation options for the National Energy Plan, research regarding the cost effectiveness of automobile fuel economy standards, and the development of models of automobile purchase and travel behavior. He is also Chairman of the Transportation Research Board Committee on Energy Conservation and Transportation Demand, and was Chairman of the Marketing and Mobility Panel of the Interagency Task Force for Motor Vehicle Goals Beyond 1980.

Dr. Difiglio received his doctorate from the University of Pennsylvania. Prior to his employment with DOE, he worked for the Highway Users Federation, the Delaware Valley Regional Planning Commission, the City of Philadelphia, Gladstone Associates, the Transportation Studies Center, and the Regional Science Research Institute.

### DR. JON A. EPPS

Dr. Epps is a Professor of Civil Engineering at Texas A&M University, a Research Engineer at the Texas Transportation Institute, and a consultant: He specializes in the field of transportation materials, pavement maintenance, and pavement design. A graduate of the University of California at Berkeley, Dr. Epps has been active in both technical and professional organizations including FHWA and NCHRP advisory panels on pavement recycling. He has also studied the energy requirements of highway maintenance and recycling.

### DR. DAVID T. HARTGEN

Dr. Hartgen received his Ph.D. in transportation planning at Northwestern University, where he specialized in research on travel behavior and attitudes towards travel modes. Now with the New York State Department of Transportation, where he is Head of the Planning Research Unit, Dr. Hartgen's responsibilities include the development of methods and procedures for transportation planning and the administration and analysis of energy-related transportation matters. He is widely known for his expertise in the area of travel behavior and is chairperson of three Federal panels on travel behavior and energy.

### MR. KEVIN E. HEANUE

Mr. Heanue has been with the Federal Highway Administration and its predecessor agencies since 1958. He served as Chief, Urban Planning Division, from 1973 until his selection as the Director of Highway Planning in 1979. In 1970-71, while on a leave of absence, he served with the United Nations Development Program as Director of the Dublin, Ireland, transportation study, preparing a multimodal transportation plan for the Dublin region.

Mr. Heanue is a civil engineering graduate of Tufts University and holds a Master's Degree from Georgia Tech.

### **MR. LEE HULTGREN**

Mr. Hultgren has been Director of Transportation for the Comprehensive Planning Organization (CPO) in San Diego for the past 3½ years, and has served with that agency for over a decade. The CPO has been a leader in recognizing energy in urban transportation planning; for example, energy has been addressed in the analysis of transportation and air quality alternatives; a study is being undertaken to investigate relationships between land use, transportation, and energy; an energy contingency plan is being developed; and the CPO is now refining its methods for evaluating the energy impacts of alternative transportation strategies.

Mr. Hultgren is an engineering graduate of UCLA and received a Master's Degree from Northwestern, where he concentrated on transportation.

### **MR. JOHN R. JAMIESON**

Mr. Jamieson is Deputy Commissioner of the New Jersey Department of Transportation, a position he has filled since 1978. For nearly 10 years prior to his move to New Jersey, Mr. Jamieson was the Director of Transit Development with the Metropolitan Transit Commission in Minneapolis/St. Paul. He earlier served as Deputy Federal Highway Administrator and Commissioner of Highways in the State of Minnesota.

Mr. Jamieson is a graduate of the University of Wisconsin and was awarded a Master of Science degree from the University of Minnesota.

### **MR. MICHAEL LASH**

Mr. Lash has served as Director of the Federal Highway Administration Office of Environmental Policy since 1970. Earlier, he filled a number of planning positions within FHWA, including Deputy Director of Planning, Chief of the National Highway Planning Division, and Chief of the Urban Development Branch. Mr. Lash has been instrumental in the highway program's implementation of the National Environmental Policy Act and the development of State environmental action plans.

Mr. Lash received a Bachelor of Science degree in civil engineering from Tufts University. He also holds two Master's Degrees, one in transportation engineering from the University of California at Berkeley, the other in public administration from Harvard University.

### **DR. ROBERT L. PESKIN**

Dr. Peskin, a consultant with the transportation group of Peat, Marwick, Mitchell and Co., works in the areas of urban transportation planning and evaluation, computer modeling, and transportation energy conservation. He has been involved in techniques for evaluating the energy impacts of rail rapid transit, has helped develop highway and transit impact monitoring programs, and has worked on a system for evaluating the effectiveness of TSM strategies. While a graduate student, Dr. Peskin participated in research on the impact of gasoline shortages on travel behavior, and co-authored reports on the impact of transportation and land use policies on energy consumption. He holds degrees from the University of Maryland and Northwestern University.

### **MR. BUIE SEAWELL**

Mr. Seawell is Executive Director of the Colorado Office of Energy Conservation, the State agency responsible for promoting and formulating plans for energy conservation within Colorado. An attorney, Mr. Seawell previously served as a member of the Colorado Land Use Commission and the Governor's Policy Coordinating Council, and he was Regional Coordinator of the Federal Energy Administration Conservation Foundation. He has hosted local television programs on environmental issues and worked as Director of Communications for the Rocky Mountain Center on the Environment.

Mr. Seawell received his law degree from the University of Denver. He also studied at the University of Edinburgh, received a Master's Degree from the Union Theological Seminary, and graduated from Davidson College with an A.B. in History.



## **MR. RICHARD H. SHACKSON**

Mr. Shackson has been Assistant Director of Transportation Programs at the Carnegie-Mellon Institute of Research since 1978. Prior to assuming his present position, he spent nearly 12 years with the Ford Motor Company, first as Assistant Director of the Transportation Research and Planning Office and later as Director of Environmental Research.

An electrical engineering graduate of the Case Institute of Technology, Mr. Shackson has been actively involved in research into innovative transportation systems. He participated in a study commissioned by Congress that examined probable changes in the future use of characteristics of the automobile transportation system. Mr. Shackson has studied the impact of the Federal fuel economy standards, and has also predicted the influence of energy prices and availability on urban transportation during the next half century.

## **MR. EARL SHIRLEY**

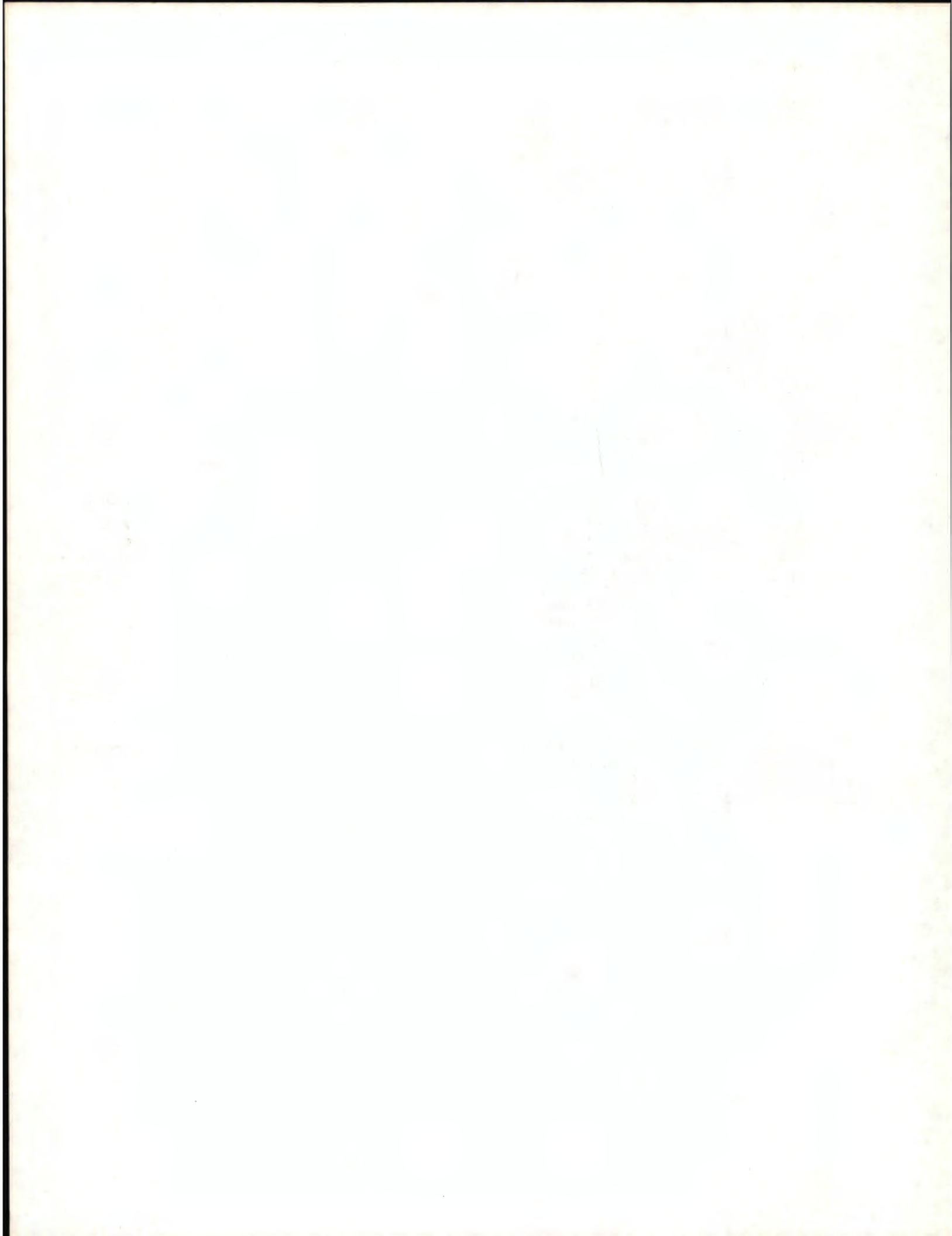
Mr. Shirley is Chief of the Enviro-Chemical Branch of the California Department of Transportation's Transportation Laboratory. For 9 years he has been responsible for assessing and reporting the physical environmental impacts of transportation projects in California. This responsibility covers such areas as air and water pollution, noise, and energy usage. Since 1972, he has developed and presented several training courses on environmental impact analysis, including a series of workshops on transportation and energy.

Mr. Shirley graduated from the University of California at Berkeley with a degree in wildlife conservation, then obtained a basic civil engineering education, and has been a registered civil engineer in California for 16 years.

## **DR. JOSEPH R. STOWERS**

Dr. Stowers is a graduate of the University of Santa Clara and Northwestern University, with degrees in civil engineering and in transportation and urban planning. As Vice President of Systems Design Concepts, Inc., he manages location studies, transit planning, and various research projects, including an UMTA study of the energy impacts of various transit improvements and operating policies. He also was co-principal investigator in an assessment of the energy and other impacts of automobile policy options and Federal actions to deal with these impacts. Between 1974 and 1975, Dr. Stowers organized and managed an intensive study, "Energy, the Economy and Mass Transit," for the Congressional Office of Technology Assessment. Presently he is assessing the prospects for transportation finances in the context of energy constraints.

Between 1962 and 1970 Dr. Stowers was employed by the Bureau of Public Roads and the U.S. Department of Transportation in the fields of urban transportation planning and policy development.



## Summary

### **What is the nature of the transportation energy problem?**

The panel members agreed that the energy problem is real and will be with us for some time. While there seems to be abundant energy available, they noted that we are currently making a transition to energy sources that will be difficult and expensive to develop. In addition, because the United States imports as much as half of its petroleum, primarily from countries in unstable parts of the world, the reliability of these supplies is uncertain. Furthermore, the rapid rise in the price of these supplies has been increasingly costly to the American economy.

According to the panel, the cost of energy will continue to rise and the cost of liquid fuels such as petroleum will lead the advance. Several panel members argued that prices should be raised to equal the replacement value or marginal cost of the resources consumed. But they also noted that the cost of transportation should not change significantly and might even decline as vehicles become more efficient. The public, faced with higher fuel prices, can be expected to act rationally by purchasing smaller vehicles, reducing discretionary travel, and modifying their behavior in other ways in an attempt to lower the cost of transportation while maintaining their accustomed level of mobility.

### **What are the prospects for technological breakthroughs in vehicles and fuels?**

In response to this question, the panel explored the prospects for further improvements in the fuel economy of present vehicles, new methods for vehicle ownership, and hydrogen, electric, and solar-powered vehicles. Each was considered to have potential, particularly in the long term. But for the period of transition immediately ahead, the panel members agreed that we would be ill-advised to rely upon the hope

of some dramatic technological breakthrough. All felt that significant conservation within existing transportation systems and vehicle technologies is needed.

Two approaches to this were discussed at length: higher fuel economy standards and special purpose vehicles. The panel considered increases in the present fuel economy standards to be practicable, provided Americans are willing to incur the cost, but it noted that at some point the cost of increased fuel efficiency could exceed the cost of fuel saved. This approach might also narrow the range of vehicle types available. Time-sharing of vehicles, which would more closely match vehicle capabilities to their functions was offered as a way to save fuel while maintaining a range of vehicle types.

### **How should transportation agencies respond?**

Recognizing that disruptions in petroleum supplies may occur at any time, the panel generally agreed that transportation agencies should respond and that contingency planning and higher energy prices are not enough by themselves. But it was also pointed out that there is no reason to panic. Present travel includes a considerable amount of discretionary driving, and current institutional and technical structures provide opportunities for conservation as well.

Transportation agencies addressing energy problems will be faced with other worthy goals, such as improving mobility and economic growth, some of which may conflict with the goal of energy conservation. One panel member pointed to many studies forecasting automobile travel increases of about 2 percent a year despite the energy problem.



Encouragement of ridesharing and "trip-chaining" were identified as two productive activities for transportation agencies to pursue. Transportation agencies should also, according to the panel, better understand how individuals respond to the changing cost and availability of fuel and be more sensitive to alterations in travel behavior. More active involvement in the legislative and regulatory process to help remove barriers to conservation was also suggested. The panel agreed that transportation agencies should seek out solutions that maximize the number of choices available to private citizens; however, it recognized that often there is a tendency to restrict travel behavior to save energy.

### **Which transportation alternatives yield the greatest energy savings?**

The panel considered a wide range of transportation alternatives, including paratransit, high occupancy vehicle lanes, ridesharing, improved signal systems, completion of major highway facilities, transit improvements, and road pricing. In general, each alternative was thought to offer the potential for energy savings, but the panel expressed a need to examine alternatives on a case-by-case basis, considering construction and maintenance energy as well as vehicle operations energy to determine which would be most efficient. Local conditions will often dictate which alternative yields the greatest energy savings. Panel members agreed that planners should look at all options together, recognizing that each has a role to play and none is invariably more or less energy efficient than any other.

The panel felt there were many good reasons to expand mass transit systems but that energy savings alone would not often justify these investments. For a very few large cities, rail transit can conserve energy by protecting the investments made in high density development. However, rail systems often require large amounts of energy during peak electrical demand periods. For smaller cities, rubber tired transit can provide comparable service to rail systems at much lower cost. The energy savings potential of both rail and bus transit depends greatly upon the ridership on the route in question.

With regard to highways, the panel suggested that considerable energy conservation potential remains untapped. Signalization improvements, ridesharing, and preferential treatment for high occupancy vehicles were frequently mentioned as areas that should receive more emphasis. To increase ridesharing, panel members indicated the need to work through employers and to use informal techniques reflecting a sociological and psychological understanding of human nature. Preferential treatment can also help encourage

ridesharing, although it may be applicable in a limited number of places and may not be fully utilized when first implemented. The advantages of roadway pricing were debated at length. On this subject, panel members recognized the political considerations involved but cautioned planners against rejecting such innovative concepts too quickly.

The energy saving potential of new highway facilities, such as projects closing gaps in the highway system, was thought to be largely dependent on local conditions. By relieving congestion, new facilities help vehicles operate more efficiently, but they may also, according to some of the panelists, encourage additional travel. And as with any capital intensive alternative, the energy required for constructing and maintaining new facilities must be taken into account.

### **How might transportation help encourage energy efficient land use?**

The panel agreed that it is not yet clear what pattern of urban development is most energy efficient. However, scattered site development remote from shopping and employment locations was thought to be inefficient from an energy standpoint. Theoretical evidence suggests that polynucleated cities, containing numerous centers of activity, can be very efficient because they maximize the opportunity for short trips. Recent urban growth has tended to be polynucleated, so American cities may now in fact be growing in an efficient manner.

Less agreement was reached on what transportation agencies should do to encourage efficient land use. One view was that the effect of transportation on land use is unclear and that consequently one cannot expect to promote efficient land use by means of transportation actions. Another view was that we do have a basic understanding of the dynamics of transportation and land use, but that the period of large scale facilities to remote areas is largely past. Hence, except in rapidly growing parts of the country, future projects are not likely to have significant land use effects. Others thought that, while opportunities for influencing land use through transportation are not great, agencies should do what they can to foster development patterns that support short trips. Several approaches were suggested, including better coordination of transportation and land use planning and participation in joint ventures and development corporations.

**What energy assessment techniques should be used to compare transportation alternatives?**

The panel noted that a number of techniques exist for evaluating transportation alternatives on the basis of energy use. These techniques allow the assessment of not only operating energy, but also construction and vehicle manufacturing energy, mode of access, and circuitry of travel.

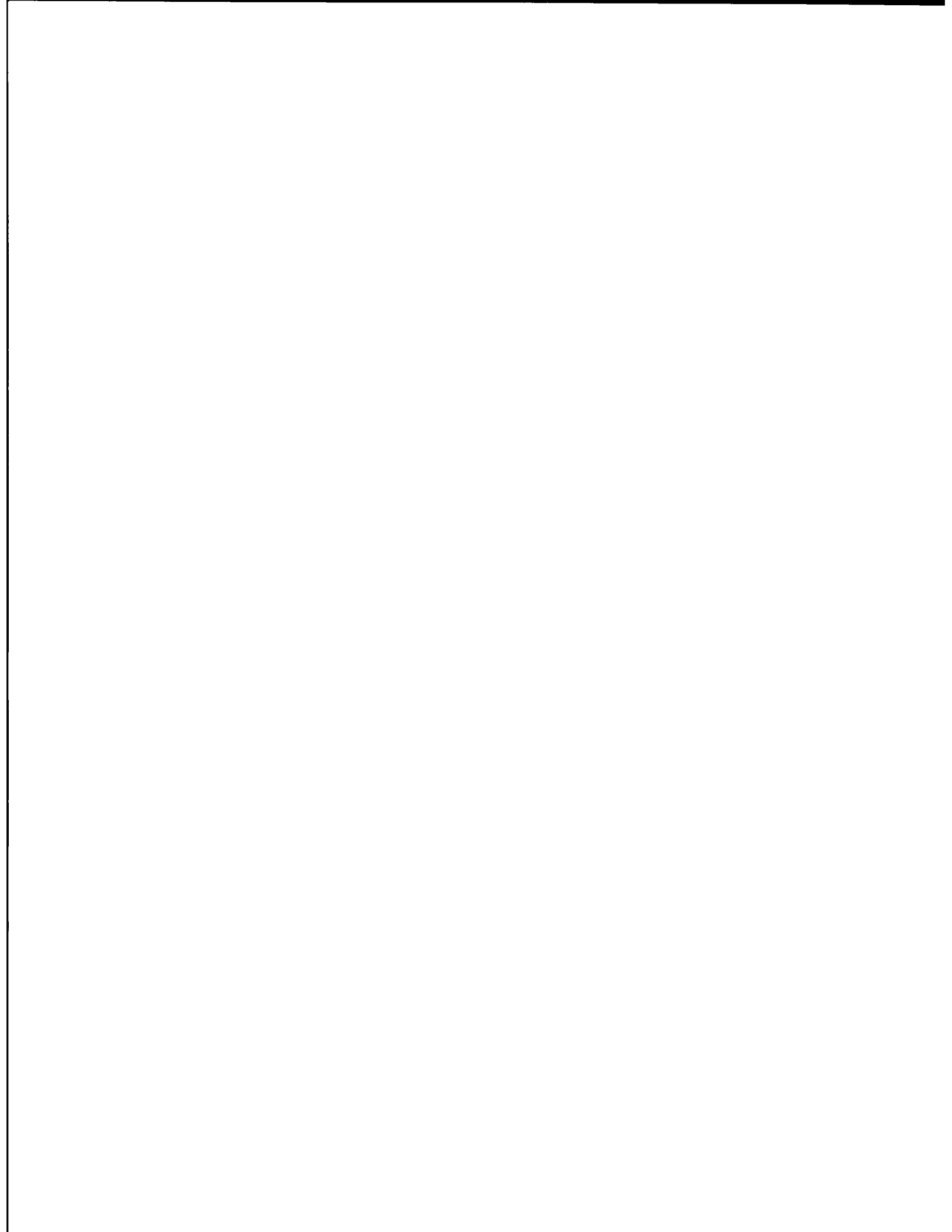
In general, the techniques were thought to be well advanced, but several deficiencies were noted. One problem is a lack of sufficient information on how travel behavior alters as a result of changes in fuel availability, fuel costs, and conservation policy. Also, much of the data used in the energy conversion factors is derived from very limited research. In addition, most available travel demand models focus on work trips, whereas many of the opportunities for conservation exist in other types of trips. Finally, available land use models are not reliable predictors of the secondary impacts of transportation improvements.





## Table of Contents

Foreword .....	i
The Participants .....	iii
Summary .....	vii
Introduction .....	1
Opening Statements .....	3
What is the nature of the transportation energy problem? .....	11
What are the prospects for technological breakthroughs in vehicles and fuels? .....	15
How should transportation agencies respond? .....	21
What transportation alternatives yield the greatest energy savings? .....	23
How might transportation help encourage energy efficient land use? .....	35
What energy assessment techniques should be used to compare transportation alternatives? .....	43
Closing Statements .....	49



## Introduction

**MR. LASH:** Over the last several months, Kevin Heanue and I have both been chairmen of FHWA subcommittees concerned with the energy problem. We have been trying to get a perspective on the subject and to identify what FHWA should be doing. One thing that has become very clear to us is the widespread confusion about energy on the part of our associates around the country. They have many questions on their minds. Some of these questions are also shared by the public.

Let me mention a few of the questions that transportation people and the public are asking. First of all, they want to know: Is there a real energy shortage? How serious is it? How long is it likely to last? Secondly, they want to know: Is the crisis largely one involving a need to conserve all energy, or one involving the need to conserve only petroleum fuels in transportation? What do we know about the possibility of coming up with a dramatic, new energy source for motor vehicles that will play a significant role in reducing the quantity of petroleum fuels used in motor vehicles?

A number of important questions concern how transportation alternatives bear on the question of energy use and conservation. To what extent can we generalize about mass transit and highway improvements of various kinds? Where do we get the best payoff in terms of energy conservation?

Other questions involve the secondary impacts of transportation improvements in terms of land development, and the impact of various forms of land development on energy conservation. For example, is there a form of development that should be encouraged by transportation agencies in order to reduce energy requirements?



Michael Lash

Finally, questions come up about what sort of energy studies should be made at the system planning stage and in project planning. Does the state of the art as we know it today permit us to make the kind of studies that are needed for intelligent planning?

The purpose of this panel is to draw on your collective knowledge and wisdom to get the best answers possible to these questions. We will try to prepare the transportation official—planner, designer, and builder—for the job ahead, give him a clearer view of the problem, and show him what he may be asked to do in the future to help solve the problem. Our job is not necessarily to get one answer, but to get the best group opinion on each question in the available time.

Before we begin discussing these questions, I would like to give each of you an opportunity to make some opening comments.

## Opening Statements

**DR. STOWERS:** I would like to just tick off a few things that are pet peeves, or things that I think we should bring up and talk about. I will just list them, in no particular order.

First, there is an incredible lack of understanding in the nation, outside of the people who have technical expertise in the field, about energy and the consequences of decisions that relate to energy. And I think there is an obligation on the profession to disseminate basic information to improve the level of understanding.

Second, the highway program should give much more attention to providing priority treatment for high occupancy vehicles. This should be done in almost every capital improvement project in developed areas.

Third, I think there is an over-emphasis in the highway program on trunk highways and major line-haul facilities that is negative from the standpoint of energy impacts. The emphasis should shift to a more balanced investment policy.

Fourth, not as much is happening as could happen in transportation systems management (TSM) because there is no specific money available and no incentive to use what monies are available for TSM activities. As a matter of fact, there are disincentives, in my opinion.

Fifth, the level of analysis is extremely poor. We know how to deal with mode shifts, we know how to deal with induced travel, and we know something about energy consumption rates, but we don't bring this information to bear on particular alternatives analyses very well.

Sixth, there is just a lot of noise and not enough good, solid work in land use and transportation policy. I think there is a vast need to improve our understanding of the relationships and to work on policies that integrate land use and transportation policy.

And finally, because of our concern with energy shortages and gas lines, we tend to look for solutions that will satisfy our demand for liquid fuels. We don't look beyond the current technologies and ask ourselves what we want our surface transportation system to be in the longer term.



Joseph Stowers



**DR. PESKIN:** When first considering transportation energy consumption as a student, and now as a professional, I have seen energy conservation efforts as a way to tie together many of the objectives of urban transportation planning. No longer do we have to consider increasing the use of public transportation and reducing automobile congestion as offsetting contradictory goals. Both of these objectives are pushing us toward the same goal of reducing transportation energy consumption.

I think it is important to realize that building new transportation facilities and other purely technological approaches are not the complete solution to the problem. There still remains the need to better understand travel behavior as it is affected by gasoline shortages.

The public, in many cases, believes that the energy crisis may be the result of the oil companies withholding information. This is because we are experiencing such a tremendous change from the past, and they want to believe that things aren't as bad as they may really be.

It is unfortunate that the public distrusts the public officials that can provide the answers to the energy problem. This is telling us that the public needs to be better informed. They need to know what the short-term and the long-term situation is likely to be so they can make better choices. They need to know what their options are, how to conserve, how to use public transportation when it is provided, and how to form a carpool.

Finally, in designing solutions to the energy problem, we have to keep in mind the systems approach. It is important to recognize that much of what we are doing may be leading us in the right direction in the short-term. In the long-term, however, we might be heading in absolutely the wrong direction. As a case in point, we can look at building rail transit lines into the suburbs. We can provide energy efficient transportation from the suburbs into downtown for the journey to work, but the journey to work is only a fraction of urban travel and total energy consumption. We need to ask ourselves what this type of urban growth is doing to the total energy picture, and I don't think that it is really being properly addressed.

In general, I feel that the analytical techniques required to solve these problems are at hand. The issue is how to assist local decisionmakers in using these tools.



Robert Peskin



**DR. HARTGEN:** Let me suggest that the public is in fact rational. By that I mean that the public takes those actions which are consistent with the difficulty that individuals can incur, the time required to achieve the payoff from such actions, and the independence, privacy, and freedom that are part of our society.

All of these considerations lead the public to behave in ways that we as planners sometimes think are not rational. When energy crises come, the public doesn't jump on buses, it cuts discretionary travel and buys small cars. The public doesn't carpool, it chain trips.

These things are consistent with the public's view of the world. They are not necessarily consistent with our view as planners. And I would like to suggest seriously that unless we begin to understand very clearly how the public deals with energy contingencies, both price and supply related, and unless we begin to match our proposals for policy with actions that are consistent with the public's view, we will never conserve very much energy. The public will do the conserving and we will do the talking.

**MR. HULTGREN:** The transit industry is being called upon to do several conflicting kinds of things. It is the savior for air quality, at least to some extent. It is being called upon to provide mobility for people who have no other way to travel. And now it must also conserve energy. The priorities of providing mobility to people who have no other way to get around and conserving energy are conflicting, and they have to be recognized as such. Where energy fits into our priorities is something that has to be wrestled with.

On my flight in, I was reading about the proposed windfall profits tax, which would provide \$15 billion for transit to improve energy conservation. A good part of this money will probably be spent to buy new buses that are heavier and less fuel efficient than the current equipment. So I wonder how much energy the increased expenditure for transit will in fact conserve.

I think our major role in transportation planning, at least in the near term from an energy point of view, is responding to demand. If we are accurate in assessing demand changes and respond to them well, we will be responding in a way that is very energy efficient.

My last comment is that we have to be rational and not punitive with respect to the single occupant auto, which will probably be in the majority for some time on our highways. When considering strategies to increase auto occupancy, we should make sure that the overall systems effect is conserving energy. We cannot just provide for high occupancy vehicles and forget about the rest of the system.

As David Hartgen said, we have to look at transportation from the point of view of the consumer and the public. They see things differently than planners, I think.



David|Hartgen



Lee Hultgren

**MR. JAMIESON:** Through the years, I have found that the public is very perceptive about their transportation needs, particularly when they are looking at petroleum shortages. On the other hand, our professionals have grown up in a field that has evolved with strong modal biases to it. One group is bus oriented, and another group may be rail oriented. These biases are very strong, and this is unfortunate.

As we look ahead now at this petroleum shortage and what we are going to do about it, we should also look at how we have made this country successful by our engineering practice of building in a conservative safety factor. In our dealings with energy, we are best to err on the safe side, as it is easier to back off if we are in error. So we ought to accept the premise that petroleum is indeed a finite resource and that it may not be easy to find substitute fuels, at least in the near term.

One thing I hope we will get into today is the important linkage between land use and transportation. I think this is something that over the years we have talked about and we have done very little about.



John Jamieson

**MR. SEAWELL:** The energy crisis is basically an economic crisis rather than a crisis of the availability of fuel. You can turn anything into a usable form of energy for doing work. To prove this, the President is going to come to Colorado and turn a rock into liquid petroleum products for the country. It is something like an \$8 billion welfare program for the automobile. It is like the old joke that if you put a large enough engine on it, you can fly the kitchen sink. Society, I believe, has more priorities than simply the private automobile and moving around by the use of gasoline.

If you believe the first law of thermodynamics, you know you can't get rid of energy, it is always around somewhere. It is just in less and less usable forms. We are in a transition, looking for a more difficult to develop resource that can be turned into energy. There are plenty of liquid hydrocarbons around somewhere, deeper and more remote and needing more capital to recover them.

I was doing a live program for the PBS network about six years ago, and I was interviewing a guy from Albuquerque, New Mexico. I asked, "How do you get people out of their automobiles?" And he responded to 11 stations on the Rocky Mountain Network, "Hell, you can't get them out of automobiles; two-thirds were conceived in the back seat."



Buie Seawell

That has been my basic feeling about the automobile until this summer when Colorado consumption dropped 14.5 percent in July and 11.5 percent in August compared to 1978. For six years, we had seen more than a 7 percent increase in vehicle miles traveled and in demand for gasoline. So we had a substantial turnaround, and we did not have gas lines! We showed—and many States did—that there was real elasticity there.

The nature of the solution somehow lies in terms of behavior. When people go from where they live to where they work, are they really trying to get to work, or to get away from home, or to be by themselves for 30 minutes while they get from home to work? We have to begin to look at what people want out of their behavior as that relates to transportation.

**MR. SHACKSON:** I am going to start by agreeing wholeheartedly with Buie Seawell's assessment that we are really talking about an economic situation and also with Dave Hartgen's assertion that the folks out there are a lot more rational than some of us in Washington tend to acknowledge. I can go on to say that regardless of how we try to subvert the issue, energy prices are going to increase, and because of the greater investment in their production, liquid fuels will lead the pack. This is going to bring on more supply and move liquid fuels out from stationary applications and into the transportation sector, simply on the basis of price allocation. By the mid 1980's the very modest steps proposed by the Administration would have probably released more than a half million barrels a day of petroleum from stationary applications.

But of greater interest to this group, I believe, is that we have seen good evidence of a price elasticity for liquid fuels. People are making their own individual decisions and, under greater price pressures, will be making more individual and household decisions on the means they will use to reduce the cost of transportation. In some cases, it will be by moves to more efficient vehicles or to more efficient transportation system alternatives. They will also be taking steps to modify their travel and transportation demands. As transportation planners, our major role is to understand the options that people have available and are going to exercise, and just try to get out of the way; try to facilitate people's ability to do these things.

In order to do that, we have to understand in a lot more disaggregated way the things that people are doing now. For example, many low income families seem to have reduced their gasoline expenditure burden by changing residential location, according to data compiled by the Survey Research Institute of Michigan. These are just correlates; I am not here to defend cause and effect at this point—but they seem to be correlated. I would make a plea for a better understanding of the way people are traveling now and the ways that individually-chosen reductions in energy demand can be facilitated.



Richard Shackson



**DR. DIFIGLIO:** Local planners and energy policy makers should view the transportation infrastructure in their region as an economic resource. In this way, they can view congestion as a symptom of a problem in the use of that economic resource. While elimination of congestion and saving energy aren't exactly the same policy, there are great similarities both between them and in the solutions which can be used to deal with them.

Perhaps 15 to 20 years ago, there was a recognition that autos received more monetary subsidy than transit companies did. The subsidy relationship between transit and autos has now been reversed, but this has not produced more use of transit. In fact, while there has been some modest increase in the use of transit over the last few years, the general trend has still been downward.

I submit that the bias toward the automobile is caused by allowing cars to use scarce roadway space for nothing. While the ultimate solution to this is roadway pricing, we all realize this solution is not politically acceptable. Because of this, planners should view the highway bias as one of time.

We can't expect rational people to switch to a higher occupancy mode unless we provide a time advantage to them. A high occupancy vehicle lane reduces the subsidy to the single occupant vehicle and shifts it toward the multiple occupancy vehicle. In this way, we can reduce congestion on the system, improve the use of our economic resource, and achieve energy savings.



Carmen Difiglio

**MR. SHIRLEY:** First of all, I am really concerned about the relationship between transportation and land use. But I don't think you can separate the other concerns that we have for land use from transportation. I don't think we can say we have to have high density population to save transportation energy and ignore the fact that we may create a monster otherwise.

I am also concerned that by expanding some of our cities we are consuming good agricultural land. As we know today, we are in debt to the Arabs, and agriculture is all we really have to bail us out. I think we really need to think about this when we talk about expanding cities and transportation systems.

I would agree that we need to provide information to the public so they can make rational decisions. I am not convinced that their decisions really are rational except as regards the specific time period in which they make that decision. So I think we need to convince people they need to conserve, not just make information available to them.

An example of that, I think, is our 55 mile per hour speed limit. We have made a lot of information available to the public that says you save energy if you go 55 miles an hour. Where are people obeying this? In California they don't. If they could relate the information we have given them to some future energy contingency, they might decide to slow down.

I disagree to an extent with Buie Seawell's remark that the energy crisis is economic rather than real. We do have a lot of hydrocarbons available, but when you factor in the time it takes to develop these resources, then we do have a very definite energy shortage.

**MR. HEANUE:** We in DOT are under a lot of pressure to establish an external energy policy. We have funding resources available for planning activities, and energy planning is an eligible item that we place high on our priority list. But we haven't formalized any regulatory requirement looking for specific products or mandating that certain types of planning studies be undertaken.

Right now we are waiting for Congress to act on the Energy Management Planning Act, which will establish a statewide framework for energy planning. But I don't know whether we should be waiting. People accuse me of having a "second coming" complex: wait until everything falls into place and then do your thing. Should we be off and running now, or should we be waiting for a broader energy conservation mandate?



Earl Shirley



Kevin Heanue



**DR. EPPS:** I think that the transportation sector has a real opportunity to make some headway in energy conservation. The commercial and residential sector uses about 20 percent of the total energy in this country, and the industrial about 25 percent. Transportation consumes 26 percent, and electricity generation uses some 29 percent. If you throw in the manufacture of transportation components—the planes, autos, buses, trains, highways, terminal facilities and refinery distribution systems—transportation uses some 42 percent of the total energy consumed in this country. So we can have a very significant impact on the whole energy picture.

It also might be worthwhile to point out that 75 percent of transportation energy is directed toward the highway component. Sixty-eight percent of this goes to cars and light trucks, and 7 percent to trucks and buses. Only 1 percent goes to urban public transit.

Transportation certainly has a big place in energy conservation. For example, if you increase the efficiency of automobiles some 10 percent, you automatically conserve about 2.5 to 3 percent of the total energy consumed in this country.

Also, we are going to be using alternative fuels. In the 1880's, the major source of fuel was wood. We then shifted to coal, and now we are in the petroleum cycle. We have another cycle coming up.

Through the last several years, I have been most interested in the area of highway materials, pavement rehabilitation, pavement construction, maintenance activities, and their associated energy and cost. From the figures that I have been able to look at and develop, it looks like somewhere between 1.5 and 2.5 percent of the total energy consumed in this country goes to highway maintenance, highway construction, and highway rehabilitation. I think conservation in this area offers an opportunity for more or less immediate implementation. You can do this on a project-by-project basis and implement it at the resident engineer's level.

Certainly you should consider not just the first or initial energy consumption on these projects but the life cycle energy, including rehabilitation and construction of pavements.



Jon Epps



# What Is The Nature of The Transportation Energy Problem?

**MR. LASH:** From your opening remarks, I didn't detect a feeling on anyone's part that we really don't have a serious energy problem. But yet we all know that many people question this. Now, do we have a problem? Is it a serious and a lasting problem, or just a passing phase?

**MR. SHIRLEY:** I think we have a real crisis from the standpoint that we import about half of our petroleum. We don't know whether we are going to have that tomorrow or whether we are going to have it next month given the instability of the source of that petroleum.

I see a very great possibility of not being able to develop alternative sources in time to substitute for the petroleum that is running out. Today we have no way to take coal and make some sort of liquid fuel. At least we couldn't begin to do that today. Looking at nuclear power plants and the changes in public attitude the last few years, there is another source that looks like it is going to drop out. We hear a lot of talk about methanol or ethanol, but we are not even sure that it is not going to use more energy than we get out of it.

**MR. SEAWELL:** Earl, I don't think you and I disagree. I began with the economic issue because you can infinitely argue how much of what kind of hydrocarbon or other energy resource there is, how long it will last, and at what rate of development. You know, somebody finds a new deposit of natural gas or oil, and everybody says, "See, I told you so. There is plenty of the stuff." They are not looking at the time factor, the rate that it is used. The problem is in terms of the transition we must make. Can we get to something new quick enough?

**MR. JAMIESON:** Look at what we are exporting to bring in this oil, the dollars, the gold, the equipment, and the machinery. We have probably spent \$200 billion in equivalents to bring in the oil during the last 4 years. In the next four years, it will probably go up to \$300 or \$400 billion. Now we are certainly spreading the wealth throughout the world this way. That is fine. But the oil producing countries desire a life style like what we have had. They are going to want more automobiles, which is going to increase the demand for fuel.

So, yes, we have a serious petroleum problem that is going to be with us for probably the next several decades until we can get a handle on how to manage it.

**MR. LASH:** Let's see if we can nail down one important point based on your opening remarks. You seem pretty well in agreement that we have passed the point in this country where we will have low cost energy. In the future, energy will be costly and prices will continue to rise over the present level.

**DR. STOWERS:** There are people that actually think the longrun energy prices may come down in real terms, just simply because there are so many options available. I don't advocate that position. I can see them going up in real terms 2 or 3 percent a year over the long term. I think that is sort of a consensus view.

Herman Kahn put it well when he said that energy is going from cheap to inexpensive. Energy is not going to become 25 percent of the cost of transportation in my lifetime, I don't think, but it is going to become a bigger factor.

When things are very, very cheap, people don't pay any attention and that is what happened in the past. The public is very poorly informed about energy costs and technology and options because they simply haven't had to pay attention to them. They are just beginning to get educated.

Certainly, the transition between now and when we have alternative sources scares me more than anything. I don't have great confidence in the ability of government, based on what we have seen with the gas lines and with technology development where government has had a hand in it in the past. Some problems are probably more institutional and regulatory than anything else. I am not very confident that we are going to manage those very well.

**DR. HARTGEN:** The purchaser of a new car can go farther on a penny of gasoline than he could if he bought a new car in 1973. And that is not even accounting for the fact that that penny is only worth a half a penny in today's money. The consumer's out-of-pocket real cost of energy for travel has fallen over the last 6 years. Even with the latest price rises, a consumer can buy a small car and keep his cost low. Why, therefore, should he not do it? Obviously he will. To him the cost of transportation energy is declining.



We are not capturing the replacement value, or the marginal cost, and that is why the cost per mile to the consumer goes down, and that is also why it is quite rational for the consumer to continue to use the automobile and gasoline. The replacement value is probably two or three times what we are charging the customer for gasoline. We need to capture the replacement value right now, before petroleum runs out, or the transition is going to be a disaster.

A price rise would affect both the demand and the supply sides. While some studies have shown that the price elasticity of demand is not high, particularly in the short term, consumers do respond by taking the rational options, buying small cars and so on, thereby stretching supplies. At the same time, price rises make alternative sources of fuel more economically feasible. I have seen literature which suggests that the breakeven cost of some of these new forms is in the range of \$30 to \$40 a barrel. That is high, but it is not really very significantly different from what Europeans are paying now, and they are driving 30-mile-a-gallon cars all over the place.

There are in fact a number of alternatives that are really not too far away, both technologically and economically. This is also a trap. The consumer sees no value to him whatsoever in conserving when in fact there are numerous options available for him to avoid having to face the pain of the future.

But society in total, of course, has to pay that price in the next generation. If there is a problem here, it is that the consumer doesn't realize that there is a problem. He doesn't see that what he does today will affect the lifestyle of his children.

**MR. SHACKSON:** If we really started charging replacement cost for energy, the marketplace's behavior would be the same as it is toward other commodities. Conservation as an ethic or whatever would not really be an issue.

**DR. DIFIGLIO:** In Europe the response to the energy crisis has largely been to rely on market forces. In this country, the response has been to have lawmakers and bureaucrats protect consumers from inevitably higher prices. The real issue here isn't so much protecting the consumer but protecting particular groups of consumers from higher prices.

In a noble and worthwhile attempt to protect economically disadvantaged people from further economic hardships, we seem to be willing to sacrifice the economic efficiency of an unconstrained allocation system. Between the two poles of social justice and economic efficiency, our policy has sort of throttled back and

forth without a coherent theme to get us out of the energy problem.

The petroleum problem has a particular importance to us because petroleum comes from abroad. It is unfortunately in the hands of suppliers who have internal political problems and are readjusting their relationships with the United States. The sensitivity of world demand is such that very slight changes in output can throw a real clinker into the operation of all economies because there is not much elasticity in demand for petroleum, especially in the short-term. Very small decreases in output by particular countries can put a real price pressure on the system. And these monies are going outside of the United States as an economic unit.

**DR. HARTGEN:** The Europeans impose higher fuel costs through taxes and most of the money goes to their economies. They don't have \$3 a gallon going to the Arabs. It is \$1 going to the Arabs and \$2 to their own governments.

**DR. DIFIGLIO:** Exactly. Our unwillingness to use taxes to discourage demand has simply been co-opted by the foreign suppliers, with the consequence that the money goes to them rather than to our own system.

But in terms of our dependency on foreign suppliers, there is an economic consequence of having these supplies interrupted because we have become very addicted to them. So it is particularly important that we look at petroleum as a special problem and one that is somewhat different from the remaining energy problem.

**MR. LASH:** One could easily say that the energy shortage problem, particularly the petroleum shortage problem, can be solved through the market system and, therefore, there is no other governmental measure necessary. But in this country, we don't seem to be following that route. Now how does this affect the transportation planner? How does he contribute to helping solve that problem?

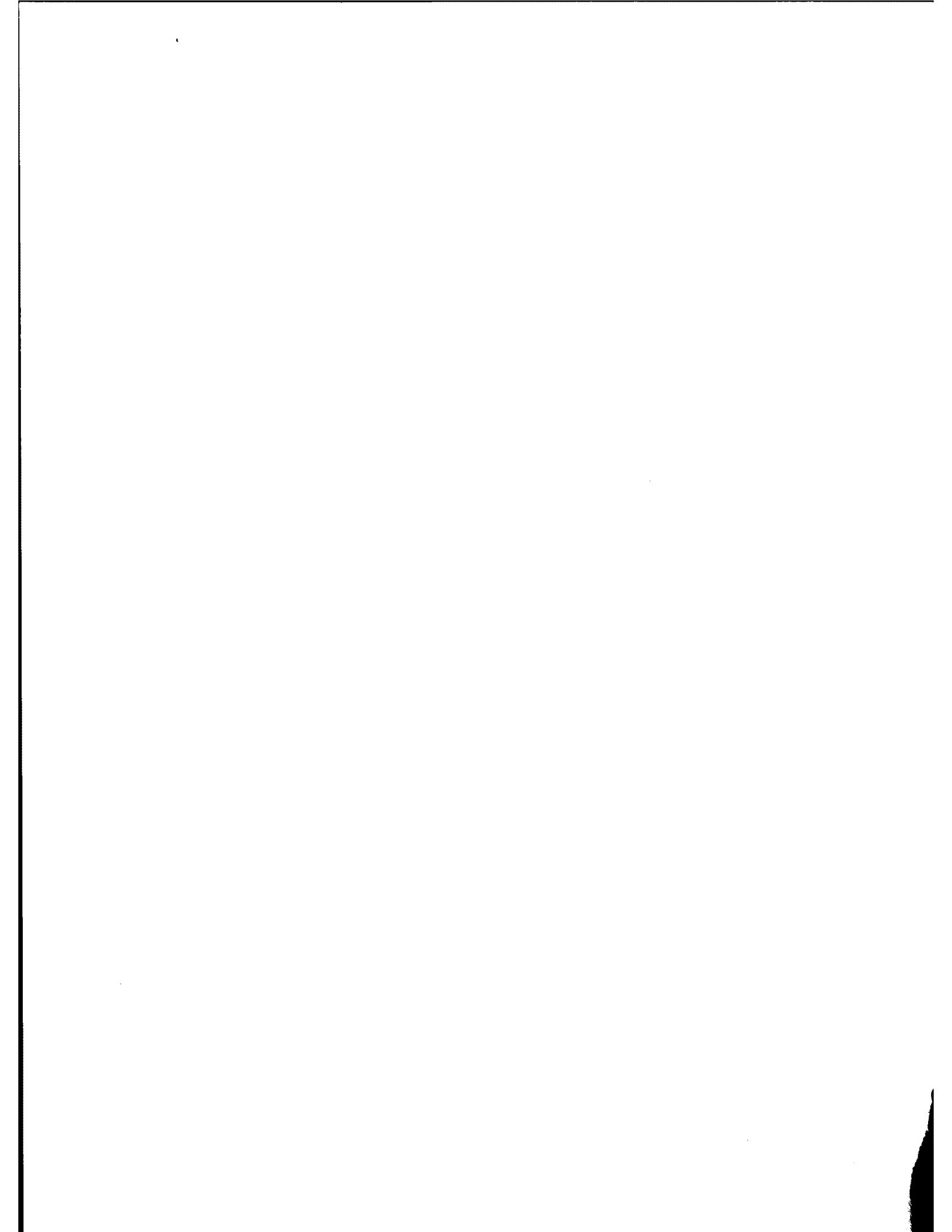
**DR. DIFIGLIO:** I don't believe that letting the marketplace do its thing is sufficient. I think it is a component of a sufficient policy. In the automobile fuel economy program, for example, we didn't rely on the marketplace solution but used government regulation instead.

The market is responding, but lead times in the automobile industry can be as much as 4 to 6 years. Market responses alone would not have been sufficient to produce the fuel economies which are now forthcoming. The fuel economy program in 1975 gave the auto industry an advantage in going into some of the technologies 5 years ago that they would otherwise have had to reject on the basis of economics.

**MR. LASH:** So you are suggesting that market forces are going to drive this whole thing and that prices will continue to increase, but government action can set into motion changes that will provide the consumer options that he can utilize to respond to market forces. The options for the transportation planner might be to develop other kinds of transportation that will allow the consumer to keep his transportation cost down to a tolerable level.

**DR. STOWERS:** Really you have got to have a two-pronged policy, one part dealing with prices, allowing them to adjust to the marketplace, and the other part to mitigate the harmful effects of the rapid rise in prices.

**MR. SHIRLEY:** We in transportation also need to look at the use of other forms of energy, I think, along with petroleum. You can convert petroleum to electricity but you can't go back the other way.



# What Are The Possibilities For Technological Breakthroughs In Vehicles And Fuels?

**MR. LASH:** We would now like to focus on the possibility of some major technological advance that will permit us to operate motor vehicles on other more plentiful energy sources. Solar energy is frequently mentioned. Speculation about electrical energy for automobiles has been particularly spurred by General Motors' recent announcement about a new vehicle based on improved automobile batteries.

What are your thoughts about this? Can we anticipate some major advance in the next few years that might radically change the energy source for the automobile?

**DR. STOWERS:** Obviously there is a great deal of hope that the electric car will prove to be economically feasible in the foreseeable future, but also there is a lot of skepticism. Very little is being done that I am aware of to look even beyond that to how we can evolve to a system that is more automated sometime in the 21st century or whenever.

We are beginning to have some skepticism about new transit technology really paying off in the next 10 years. But I think there is a lot of confidence that some kind of technology will prove to have great benefits in the long term. On the highway side, for example, there have been some exploratory studies of automated roadways and some tinkering with automobile electronics, like on-board computers, communications systems, and electronic controls.

If you look to the very long-term future, I envision integrated guideway systems having the potential to serve different forms of transportation—perhaps including personal and captive transit vehicles on the same guideway. I don't think enough attention has been paid to how we evolve and coordinate these separate research and development efforts over the very long term so that an integrated single system evolves.

**MR. JAMIESON:** The people mover demonstration activity is revealing. A system that circulates within the central area of a major center has a lot of potential. People movers could enhance the walk trip. People will walk a short distance and use a people mover from one internal node to another, reserving automobiles for the extra long trip.

There are some real opportunities to save energy over the long term. These savings don't show up when you just look at one particular mode by itself.

**DR. HARTGEN:** We have a short time left to replace the automobile with something else, either some new fuel that allows continued automotive transportation or some new system that at least gives us some of the mobility of the car. One of the most attractive prospects is the electric vehicle. As I understand it, electric vehicle technology is held back by battery technology at this point.

Recently, we surveyed all the owners of electric vehicles in New York State, all 110 of them it turned out. We discovered, as you might expect, a great deal of satisfaction with some of the characteristics of these vehicles, particularly with their low operating cost, noise, and emissions. A great deal of dissatisfaction, however, was expressed about their performance. The message we got very clearly was that, if these vehicles cannot perform within the existing transportation infrastructure, their potential will be limited.

We will not in my view make significant energy savings in this area unless we can develop vehicles which perform the way conventional vehicles do in terms of range, speed, controllability, and possibly crashworthiness.



**MR. SHACKSON:** Let me just play the devil's advocate and take an opposing view. There is a body of opinion which says that the auto industry has been far too long operating on the assumption that every vehicle must be a general purpose vehicle. The traditional family use of automobiles has been to buy a car and pretty soon buy another car and relegate the first car to second car use, so that as the car is moved through the chain, each must do the job of every other car. We seem to be at a point now where we are quite prepared to accept the notion of time-sharing in such things as condominiums and computer terminals. And some of us believe that we may be at the point where that same notion might be applicable to cars.

If I were able to go to my dealer and buy a four-passenger economic car for my general purpose use and, as a part of that purchase price, buy a share of a van or an electric city car, it might cause me to think twice about buying a 10-mile-per-gallon van and driving it all month

because I needed it twice a month, or conversely, being reluctant to buy an electric car because it didn't meet all of my needs. This idea offers potentially far more than does continued improvements to the technology of all vehicles.

It may be that the transportation planner's interest in this is to facilitate such things with priority treatment for these time-shared vehicles, or to make pick-up and drop-off spots available throughout a region. I see this as quite a near term option.

**DR. STOWERS:** I think that a transportation planner could do a little more than what Dick is talking about. I think he could conduct an experiment in part of a metropolitan area, and make cars available through the kind of system that Dick has described. You have to be able to get that van or that specialized car quickly. It has to be quite near you. And so I think you would want to conduct the experiment within a fairly tight geographic area.





If you were to do this in a new development, you might be able to cut down the number of parking spaces by 50 percent. Then you could reduce a lot of energy consumption in construction as well as in the use of fuel.

**DR. HARTGEN:** I don't think we should leave on the record the idea that institutional adjustments which change the ways in which cars are owned and used may bail us out of this problem. That ignores the unique relationship of the car to its owner. You would not propose to rent a pair of shoes or a suit coat, and I think we need to understand that cars in fact are not just transportation vehicles, they are personal property. They are extensions of personality and self. These characteristics are at the heart of the buying process.

There are many trips that are short, it is true. However, the energy used in such trips is also small. And therefore the payoff to be gained by using, shall we say, a second class vehicle for such trips is quite small.

I would, like you, honestly like to see the day come when we can match vehicles to functions. But for the remaining part of the century I think we are probably stuck with the present mode of ownership. Given the capabilities of fuel economy standards to increase efficiency and the willingness of the manufacturer to do so, I don't see why the consumer should be compelled to change his habits. However, this whole area is ripe for research and certainly ought to be investigated thoroughly.

**DR. STOWERS:** What we are talking about is substituting for the second or third or fourth car in the family with the specialized vehicle. The family might still have the car that they identify with and own and maintain.

**MR. SHIRLEY:** The technology to build a so-called urban vehicle existed some time ago. The transportation planner can make these things feasible by building 7-foot wide urban vehicle lanes instead of HOV lanes.

**DR. HARTGEN:** But no planner will propose to invest that kind of money without the demand being there, and the demand is dependent upon the willingness of society to adopt the concepts. As practical planners we can't get too far ahead of the willingness of the consumer to respond.

**MR. LASH:** Do you feel that providing the consumer access to specialized vehicles is the best that we have to offer from technology? Or will there be some change in the basic energy system used in vehicles? What you outline is really a new way of putting together things we now have rather than real change.

**MR. SHACKSON:** I see this concept not as an alternative to further technological development but as a complement. I am suggesting that from the consumer's standpoint it might offer a better transportation environment than would occur by forcing average fuel economy to go to 40 or 50 miles per gallon with a consequent reduction in the range of vehicle types available.

With regard to the question of the straight technological fix, a panel convened by the Department of Transportation in Boston last February concluded that there were no new physical laws to discover, that substantial fuel economy improvement would be gained by careful application of the physical principles already known, and that you could probably go as far as you were willing to pay for in terms of reduced vehicle size and weight. The concern was that one could move the price of the vehicle too far beyond the discounted value of the fuel saved.

I think it would be a serious mistake to maintain a 50-mile-per-gallon corporate average fuel economy standard, particularly if you include the light truck class within this spectrum. Improvements to automobile fuel economy are now costing on the order of \$4 to \$5 per million BTU's saved. Insulating a house costs \$1.25 per million BTU's saved. And so I think we have to be a little careful about blindly pursuing the automotive technological fix when there are a lot of other measures that bring us more bang for the buck.

**DR. DIFIGLIO:** We have to realize that there are a number of proven existing technologies that can do us a lot of good. Our immediate energy problem is in the next 15 to 20 years, so the public policy decisions to deal with that problem have to be made now. The basic responsibility comes back to examining our own opportunities. All sectors have to contribute. And I think, in terms of proven technologies, the automobile still has somewhere to go.

Existing fuel economy standards are cost effective. They save consumers, according to my own estimates, between \$440 and \$750 over the life cycle of a future 1985 automobile. And even at the margin, the last mile-per-gallon of fuel economy improvement in 1985 will be cost effective to the consumer.

Looking toward a future vision when some new technology will come out and save us does not release us from the responsibility of pushing the fuel economy standards so that they not only maximize private benefits, but also maximize social benefits, which means higher fuel economy standards than now exist. When we are talking about the automobile, which consumes 33 percent of the petroleum used in the country, we are not in a position to say that somebody else should do more and we should do less.

**MR. SEAWELL:** I think it is very hard to predict what mode of transportation will evolve or what technological changes will take place. The very nature of the future is that those of us who think we know how things will evolve are probably the ones who know least about what will occur.

But some things, I think, are important in terms of human behavior. Automobiles are fun to play with. I think we should try to set up ways that people can play with their cars so that we can get on about the business of whatever transportation is really for.

In the next century, we will not use cars as we know them now, with internal combustion engines, for much of our transportation. But I bet we will still have automobile races. And that will be rather good. We don't use horses anymore for much of our transportation, but we still have horse races. Think how uneconomical it is to keep a horse! It will be even more uneconomical to keep a car, but people will still love to have a car.

**DR. STOWERS:** I mentioned before that I think we ought to be looking into the 21st century because I think there are some extremely difficult transitions ahead, not only in terms of energy, but also in terms of what you do with your transportation system.

If you are going to use solar energy or fusion energy in the future, it is probably going to be through electricity, and it is probably going to come to the vehicle through a guideway. The problem of transition is deciding where these guideways are all going to be, and that is where I think the transportation planner may have a role in looking at the long term. We are going to have to make use of existing rights-of-way; we are not going to go tearing cities and roadways apart to build new guideways.

I am not sure we have all the technology that we need for automated systems that are reliable and have a high capacity. There is a lot of technological development to take place. But we have to think about how the technological evolution can fit with the capital investment in facilities that we now have. It has got to be evolutionary, it has simply got to be.

**MR. LASH:** I think one of the most provocative points you make, Joe, is that we could go to guideways that could be utilized by individual vehicles. That really is a major change, because it would allow us to shift the fuel source from petroleum energy or even a battery to electric power.

Do you have anything to say about solar energy? Where does that stand?

**MR. SEAWELL:** We are going to see some surprising technological leaps in photovoltaics. The cost is getting ready to really fall. That will mean that we have a number of options. You can obviously charge batteries with photovoltaics. We can also get to a hydrogen-based transportation system tied to photovoltaics. You can put photovoltaics on the top of, quote, "a filling station," and make hydrogen right there rather than sending it through a pipe. Then you drive in and get your tanks filled up with hydrogen. The whole memory of the Hindenburg notwithstanding, I think the hydrogen possibility for transportation is a good one, and it is tied to solar energy. It is basically in infinite supply for us.

The other thing is we presently have day-peaking powerplants with excess evening capacity. To transition to the hydrogen photovoltaic scenario, it might very well be worthwhile to use the electric vehicle as a way to pick up the excess power in the evening when you have many turbines continuing to spin without producing electricity.

**MR. HEANUE:** The Harvard Business School Energy Futures book compared the evolution of photovoltaics to the chips used in electronic calculators. Photovoltaic technology is only 15 years behind in terms of relative cost. If it evolves anywhere near as fast, it could come on very strong.

I think we are rapidly becoming a nation of multivehicle households. Even the percentage of households with three vehicles is growing. I think we have got to do a lot to stimulate special purpose vehicles, and there is, I think, a ready market today if we ease up on restrictions on the use of those vehicles on public streets.

In some Sunbelt retirement communities, golf carts are permitted on the streets now. I think the Federal Government ought to stimulate experiments in the use of these as a form of electric-powered transit, so the elderly who no longer want or have the capability to drive a regular automobile can get around.

**MR. JAMIESON:** I think that every transportation planner should have a dead of winter electric vehicle race. The weakness of the system is that batteries fail when it gets cold.

**MR. SHIRLEY:** Like Buie said, probably hydrogen will be the long-term fuel. But I don't agree that we would generate it with photovoltaic cells unless we had a tremendous breakthrough. As it stands now, Stanford Research found a way to manufacture silicon cells fairly cheaply. But a silicon cell is not a very effective photovoltaic cell. Some people indicate that even if silicon cells were free, you couldn't generate electricity economically to power transportation.

Any of these technologies, the hydrogen technology or the electric vehicle technology, will demand a tremendous change in the distribution structure. And if we are talking about taking all of our internal combustion engine technology and changing it to electric motor technology, we are talking about an investment that is just fantastic.

The Department of Energy is doing work on a hydrogen engine, and I think that will provide us with an engine that is reliable. But I don't visualize hydrogen being available until fusion power comes through. So I see that as a very long-term thing.

**DR. DIFIGLIO:** We can't be too casual about substituting electrical BTU's for petroleum BTU's. And the automobile presents a particularly significant problem. Not only do you have the normal production and transmission losses associated with conversion of energy into electricity, but also you have the battery.

The battery poses two problems. First, efficiency is lost putting energy into a battery and taking it out. Second, even with General Motors' recent breakthrough, batteries have to be replaced. The General Motors system requires batteries to be replaced every 30,000 miles which, I understand, is almost a \$2000 investment. That completely obliterates any economic value compared to the fuel savings.



I would be rather astonished if within the next 25 years the electric vehicle makes any significant penetration into the American market because of its cost and performance, which are two strikes against it. I think that the transportation system will be the last user of liquid fuels, and that users who don't have to rely on battery technology for storage of electrical energy are best advised to switch to electricity.

We have a good electric and hybrid research vehicle program which is going to demonstrate these vehicles and put them on the street to determine consumer reactions and push the technology as far as it can go. But if we depend more and more on electricity, we will have to develop new ways of providing it. The Department of Energy has extensive research into solar energy, cogeneration, and both the plutonium breeder cycle and other breeder cycles which show promise. Fusion technology is promising, but there is no reason to believe that fusion technology could ever be achieved at a reasonable capital cost.

I am wary of looking toward some saving technology that is going to get us out of this problem. We have to utilize existing technologies to the maximum now. That means the most efficient automobiles that are possible with the current technology.

**DR. STOWERS:** On the subject of technological possibilities, you have to throw in telecommunication. I don't think that telecommunication is going to substitute for a whopping amount of travel. In fact, I have the suspicion that if you invest in and push telecommunication heavily, you will generate more travel. That is obviously what the telephone has done.

We have very poor research on which to base any kind of conclusion, but there certainly are some areas in which telecommunication can substitute for travel. I think there are possibilities, but I don't see any panacea, either.

**MR. HULTGREN:** We did a little work on that, and one of the conclusions we reached was that telecommunication can expand your sphere of interaction, and that can actually result in more travel.

**DR. DIFIGLIO:** One area where telecommunication might help is in the area of aiding efficiency. For example, say you are on an airplane about to land. If transit regulations allowed this sort of thing, you could easily find out the destination of everybody in that plane, and in every other plane coming in, and organize a system of commercial vanpools or jitneys to take people at low cost to their destinations. We might even envision a system of traffic control to advise individual vehicles of better ways to avoid congested areas. Or we may have on-the-spot carpool formation, where people can, on a ready access basis, find out that a carpool will come by the corner of Elm and Third at 8:10.

So I think telecommunication is an invaluable opportunity for allowing higher capacity loads, if sufficient changes are made in transit regulations which generally prohibit this kind of activity now.

**MR. LASH:** All of you seem to feel that, although there is speculation about breakthroughs in motor vehicle energy sources, there is still a lot of doubt as to whether we can look forward to them in the near future with any confidence. And even if we get electric powered vehicles through some breakthroughs, there are still a lot of problems. So we cannot rely on changes of that kind to solve the problem.

You all seem to be saying that we have to do everything we can with the present system. There is no justification to reduce our efforts to improve the present technology, the present system, on the basis of foreseeable technological breakthroughs.



# How Should Transportation Agencies Respond?

**MR. LASH:** What does all this mean for the transportation official and planner? What do you tell a transportation official, planner, and designer who has heard our discussion to this point? What is your general advice to him?

**DR. HARTGEN:** First of all, I would say don't panic and go off half-cocked, yelling about the world falling upon us. There are a lot of options available, and there is capability for improving existing technology and systems. There is a lot of slack in travel behavior, and a great deal of flexibility within the institutional and technological structure that we presently have. We should certainly make the most of these opportunities.

**MR. HULTGREN:** There is a lot of slack in people's driving behavior. Up until last year, the public was making 20 percent more trips per household than 10 years ago due to major increases in discretionary travel. In our region, 75 percent of these new trips were made by women. When the energy crisis situation hit, travel was cut back, and there was no major crisis in our region. People accommodated. There is a good 10 to 20 percent slack that can be eliminated without creating any serious problem.

**DR. STOWERS:** Almost everybody who looks at all the options and looks ahead 20 years comes to very similar conclusions on how much automobile travel there will be in the year 2000. Travel is going to grow something like 2 percent a year plus or minus 1 percent. Conditions are not going to be an awful lot different than what they are right now, except that travel and congestion will increase. Most of these analyses take into account the changing market for different size cars, energy prices, demographic structure, income, and national macroeconomic forecasts that have been made.

But automobiles are going to consume less total energy despite the increase in travel. After the next couple of years, total automobile energy consumption is going to decline for quite a few years as a result of fuel economy improvements.

**DR. PESKIN:** Does the transportation planner today really have the mandate to save energy in the long term? Certainly, he has to take action on short-term conservation; that is where contingency planning is coming in. But a lot of issues that are being raised here refer to the problem of conflicting goals which I mentioned in my opening remarks. We are finding many cases where the goals of conserving energy and main-

taining or improving mobility are conflicting. This conflict affects the decisions and the recommendations that planners make.

Currently I am involved in some planning work in Houston, and in Houston as in other large southwestern cities the primary goal for the region is economic growth. This seems to run counter to the need to conserve transportation energy. Therefore, the types of transportation projects that are being identified, the ones that are gaining support from the public, in fact may not be the most energy efficient modes and projects to select.

How do we deal with these conflicts? I think if the local politicians in larger southwestern cities were to be posed this question, aside from handling short-term energy emergencies, they would say that economic growth is much more important than the long-term transportation energy situation.

**MR. SEAWELL:** In case the favorable opinion about the automobile over the next 20 or 30 years does not turn out to be correct, I think the planner should be advised of the early psychological studies of rats and mazes. The reason that the rats' performance improved with practice was not that they learned to memorize the maze, but they learned to turn around in dead ends more quickly. The planner is going to have to learn, especially in transportation, to turn around in dead ends more quickly. The automobile just may, in the future, be one of those dead ends.

**DR. EPPS:** The bottom line is to recognize the dead ends.

**MR. SHIRLEY:** I think one thing the planner has to understand is that these perturbations in the fuel supply are going to continue. There is no way they are going to go away; they are going to be a fact of life on and off. I think the dips are going to get wilder, especially when the eastern nations begin to compete for available oil supplies. Russia is going to become a net importer, maybe next year, and she has been exporting an awful lot of petroleum to the eastern block nations which will no longer occur.

I think in general people are looking at the transportation planner and what he can do. From a short-term standpoint, we are talking about TSM actions in general. We can save energy by

relieving congestion and increasing the load factor. Ridesharing is going to be good, and getting people to trip chain is going to be good. Out of all the TSM strategies, these seem to be the most productive. That is not to say that you don't get incremental savings from other strategies, but if you had to devote your attention to just a few actions, these are the places to go.

**MR. SHACKSON:** It is important at the local level that the planner understands his or her constituency, which is something we kind of missed in the past. We have been preoccupied with aggregate measures of transportation, but the microresponses are of interest and can be explored at the local level without a sophisticated data collection effort.

There are very significant regional differences in people's responses, partly climatological, partly intervening opportunities. One can't generalize on a national basis as to what options people are apt to pursue. There are options out there that people are going to discover and use, and it might be well to begin to understand them a little.

There is also, I think, a State level role that the transportation planner needs to be aware of. A recent bill changed the regulatory status of employer-based vanpooling and eliminated all of the regulatory hassle. This bill was introduced and fought for, not by transportation planners, but

by private people who wanted to implement vanpools. The transportation planner can appropriately be just as concerned about the introduction and successful passage of that sort of legislation at the State level as he or she should be about protecting highway maintenance funds.

**MR. LASH:** I think one worry in the minds of most transportation planners is how to deal with this problem in a way that allows them to maximize social benefits, giving people freedom to choose travel options best suited to their own needs. Transportation planners have really been troubled with the air quality program where the thrust has been to slash public travel. They would prefer to find a solution that maximizes options and choices based on a philosophy, as some of you have expressed, that the public is rational and, given the right choices, will make intelligent decisions to satisfy their own needs and to achieve larger social benefits. I think that the air quality program is in trouble because there is a lot of public antagonism to many of the measures being offered to solve the problem.

In this panel I seem to hear people saying contradictory things—on one side, let's trust the public, let's give them options; on the other hand, let's narrow those options so that they will choose what we want them to choose rather than what they really want.



# What Transportation Alternatives Yield The Greatest Energy Savings?

**MR. LASH:** We want to now discuss transportation alternatives and the impacts of these alternatives, looking at what can we say about the efficiency of various types of transportation alternatives. Let's hear what you have to say about various types of mass transit improvements, and also compare mass transit with highways. Then let's talk about various types of highway improvements and perhaps get into operational questions such as carpooling, parking restrictions, and what-have-you. What can we say about these various alternatives that might be useful to transportation officials?

We also want to come back to that important matter of how we can reflect the public will. How can we respond in a way that will make our solution palatable to the general public? How can we respond to the natural, rational attitude and practice of the public, constraining their choices as little as possible, and providing them with as many options as possible.

I think we have already seen this morning the difficulty in doing that and still getting results. There is a tendency to want to increase options but, at the same time, we also feel a tendency to restrict public choice.

**MR. SHACKSON:** I think that there are untapped opportunities with private providers of public transportation services. A lot of things have happened recently in terms of more favorable insurance treatment, more favorable IRS treatment, and other things which offer incentives to either employer-based vanpools or quasi-government agency-based vanpools. It seems to me that the transportation planner needs to develop a much stronger communication with these potential providers of service, and that he or she in turn needs to be provided with better information on the conditions that now exist for establishing such services.

**DR. STOWERS:** Paratransit is one particular mode that I think doesn't get enough attention. While transit companies are going after the full peak load, at very high subsidy levels, paratransit operators, jitney services if you want, could provide a portion of that peak a lot cheaper and a lot more efficiently.

The best operation I can think of in the country is the jitney operation on Mission Street in San Francisco. They take a very high proportion of the peak load and, using limousines basically, they provide a fixed route service. You just flag

them down on a main route. They can do it cheaper than the MUNI or the BART system can.

**DR. HARTGEN:** Energy considerations cannot be separated from other considerations. Every transit rider who jumps onto this jitney system represents an additional deficit that taxpayers have to pay. Transit service is operated in any case, and these riders represent a fare that is not provided to the company. Public transportation providers are not enamored with the idea of skimming off the top of their peak and passing it to private entities because the public winds up paying twice.

**DR. STOWERS:** Paratransit can skim off the top and reduce the operating subsidies to mass transit systems. I think there is not a metropolitan area in the country where that isn't true. Every extra peak-hour passenger is a burden to public transportation systems, and there are many markets in which private paratransit operators could operate profitably in peak periods if allowed and encouraged to do so.

**DR. HARTGEN:** I think paratransit is overstated as an approach. It has got too much energy consumption for too little payoff.

**DR. DIFIGLIO:** I would, first of all, be very reluctant to define paratransit in terms of modal characteristics. The whole essence of paratransit is private market involvement in what is currently a regulated industry. To look at the paratransit question, we have to think in terms of revising economic regulation of public transportation, as opposed to coming up with a new vehicle or scheme of operation for those vehicles.

Obviously, existing suppliers have something to lose by having their monopolies removed. Taxicabs have a rightful concern that profitability would be threatened, and transit labor would have something to lose too. But I think the transit industry itself, as apart from transit unions, would potentially have a great deal to gain, because the current operating ratios of peak to average daily load are around two to one. This is a very difficult type of service to maintain, even with split shifts. So if paratransit can alleviate peak-load demand, I think transit management has much to gain.

Ultimately, public transportation cannot advocate free fares or total subsidy and fear "cream skimming" at the same time.

**MR. HEANUE:** Paratransit can be cost effective in extending services and may be energy efficient. Some transit operators around the country have been very effective in promoting this.

**MR. LASH:** Many of you have said that you have to look at all modes available to you. I think the point about paratransit that could be significant in this context is that this is one possible device that at least has to be looked at as an option.

**DR. STOWERS:** I think there are far more opportunities for high occupancy vehicle lane management systems than we are now engaging in. Almost every capital investment that adds capacity in a metropolitan area ought to be looked at in a creative way, in terms of possibilities for high occupancy vehicle management systems. Whenever we add new capacity, we are not taking something away from somebody, and it is more politically feasible to talk about giving priority. I am not talking about physical separation, or heavy construction all the time, but rather management to achieve priority. And we ought to be doing a lot more with enforcement of those operations that don't have physical separation.

**DR. DIFGLIO:** The I-66 corridor in the Washington area is to be dedicated entirely to high occupancy vehicles during peak hours. The facility would have been an 8-lane, unrestricted highway, but there was a tremendous amount of opposition, and I think here is one of the better examples of where public debate and citizen participation led to a rational solution. We are now getting a four-lane facility which exemplifies the principle of design for total use.

I think the highway planner should look at all new radial highways coming into the city and consider dedicating the entire highway to high occupancy use.

**DR. STOWERS:** I would go one step further. I think widening a beltway, not just a radial, offers a good opportunity for this treatment.

**DR. HARTGEN:** There is another view here. Let me point out that there are approximately 275 cities in this country with over 50,000 population, and only a handful are big enough to seriously talk about high occupancy vehicle lanes on more than one or two facilities. That leaves us with another 230 cities which do not have the capability to talk seriously about HOV lanes. Those 230 cities constitute 70 percent of urban energy use, and we have got to focus on that.

I hope we'll talk about things like ridesharing

for work and nonwork travel, flextime, and better use of existing capacity, rather than about options to expand capacity in innovative ways.

**MR. HULTGREN:** We have a radial Interstate being constructed. But on the portion nearest downtown the peak travel is going in the opposite direction. You can't just say, "Let's build an HOV lane downtown" when the peak is going the other way. That doesn't help much.

**MR. JAMIESON:** I think it is great to have this major interest in ridesharing. But I have yet to see some good statistics that show we are gaining on the problem. The only set I have seen are for commuter trips into downtown Minneapolis where peak-hour auto occupancy has dropped over the last 10 years from 1.4 to 1.2.

A lot of jobs are not downtown. They are being dispersed, so you are breaking up the carpools that were there. Cars are getting smaller too. So I don't think we should be overly optimistic. But it is a very good thing to do.

**DR. DIFGLIO:** In looking at Shirley Highway data, it is clear that people do not take advantage of a high occupancy facility right away. The data for the express lanes show there has been a steady increase since 1973, when those lanes opened up into the city. There was no sudden upsurge of use when the facility was made available. But on a gradual basis, the number of carpools and buses using that facility has been steadily upward. Looking at 1978 data, I believe we are talking about 4,000 vehicles daily as opposed to less than 1,000 vehicles when the facility first became operational.

One of the unfortunate problems of a local planner bringing in an HOV facility is that, unless he demonstrates a quick response to the system, people are going to be quick to say it is not worth it. But a facility could be underused for 3 to 5 years until people adjust their riding habits, location patterns, and carpooling relationships. You have to expect to endure some criticism and some underutilization during that period.

**MR. LASH:** Let's look at other kinds of possible actions. What would you do if you were immediately mobilizing all your capabilities as a transportation official in the metropolitan area to start solving this problem? What do we know enough about to feel that the probability is good that these things will help while we also make studies in areas where we can't make intelligent decisions without studies?

**DR. HARTGEN:** Let's focus ourselves for a moment on the single objective of saving energy.



Every time you add a vehicle to the road you have to ensure that the average occupancy of that vehicle is greater than the average occupancy of the other vehicles on the road. Otherwise, you will lose energy instead of gain it. The conclusion of that to me would be to use as much as possible of the existing vehicle fleet.

Take, for example, client-agency transportation services, like Meals-on-Wheels, school buses, even commercial vans. There is just an incredible array of such vehicles. And they carry more people in some metropolitan areas than do bus companies. They often have four or five times as many vehicles as do bus companies. Yet they operate completely uncoordinated with each other or with transit companies. The point is that we have effectively much more capacity out there than we are generally using.

The constraints are institutional. Many of these problems could be solved if we could get these groups together, work out coordinated approaches, and integrate these specialized services with more general services.

Ridesharing is another area. I am disappointed with the actions in ridesharing that most MPO's appear to be willing to take. Even with the two-for-one money that is available, they would much rather spend that money on capital than on

operating programs.

The present nonridesharers, the single occupant auto drivers, are those you want to attract. They are never going to be attracted by the techniques we are using to attract the present ridesharer. You have got to go with a personal approach, with a very informal, psychological, sociological understanding of ridesharing. It is not basically, at its heart, an economic problem. In fact, we see the incidence of ridesharing to be greatest in some of the smallest companies because those people are close-knit. They even live in the same communities in many cases. The companies have evolved to become very involved in ridesharing. The same way with vanpooling. Some of the smallest corporations are the most involved in it.

We are not learning from these observations. We are talking about things like computer matching and formalized, structured, privacy-involving approaches. We pass this stuff to the consumer and then we wonder why he doesn't accept it. But it doesn't deal with the reasons that he is using to make these choices.

**MR. SHACKSON:** The transportation planner should think differently about urban transportation and perceive employer ridesharing as a part of his system, even though he has no direct control over it.



**DR. HARTGEN:** That is one of the things I would tell an MPO planner. We need to involve private corporations much more in this problem. Historically, private businesses have had a small role to play, but we are seeing that changing quite rapidly now.

**DR. STOWERS:** There is a Government role here in deregulation, as Carmen and I have been saying. I think there is a role in terms of writing model ordinances that deal with regulations in a more imaginative way.

**MR. SEAWELL:** People usually get involved in transportation planning only when you are going to put a clover leaf on top of them, move a transit stop, or do something else to them, and they are mad when you deal with them. It seems to me there is a real opportunity to go the other way around. If I were saying something to the planner, it would be to go into a community with something to offer.

Communities can coalesce around transportation modes, at least the one where I live surely has. We insisted that half of two major arterials be taken over by bicycles, and we got what we wanted. That has been great for our neighborhood. The community was assisted rather than deterred by the regional planning entity for transportation.

The city really does still belong to the automobile. But the transportation planner is one who can help change that balance. One way is to provide a chance for different uses of the corridors that we have. You know, the bicycle is a heck of a good transportation device for close commuting. My moped is fine as well. We are cutting down on the efficiency of the cars that are still trying to jam along those streets. But I think we are beginning to see more people take the bus or ride bikes.

The improvements in clocks, using the types of things people have in their wristwatches now, allow signal times to be fixed, and they don't vary. So, rather than having to string wires or phone cables between signals, you can essentially interconnect them without an interconnect, cheaply and efficiently.

**DR. DIFIGLIO:** If you want to change your mode of operation to suit conditions, you can go further than the one point optimization and go to continuous optimization over time using the computer.

**DR. STOWERS:** There seems to be a lot of institutional inertia here. Why isn't more being done? One of my opening remarks was that we are not doing nearly as much in TSM as a whole,

certainly not with our Federal dollars, because it is too difficult. It is easier to spend Federal and State money for big projects in order to minimize the paperwork per dollar.

**DR. EPPS:** I think in the short term there must be some key segments of metropolitan highway systems that should be completed. Partial sections have been held up for years, and the fuel savings that could have been achieved by building those facilities 10 years ago is enormous when you consider the amount of traffic that now exists.

**MR. LASH:** Let's focus on that point because today many metropolitan areas face gaps in major facilities. As a matter of fact, one of the arguments used against the completion of those facilities comes from the energy side. Whether it is a competent opinion or not, some argue that such facilities result in excessive consumption of energy and, therefore, should not be built.

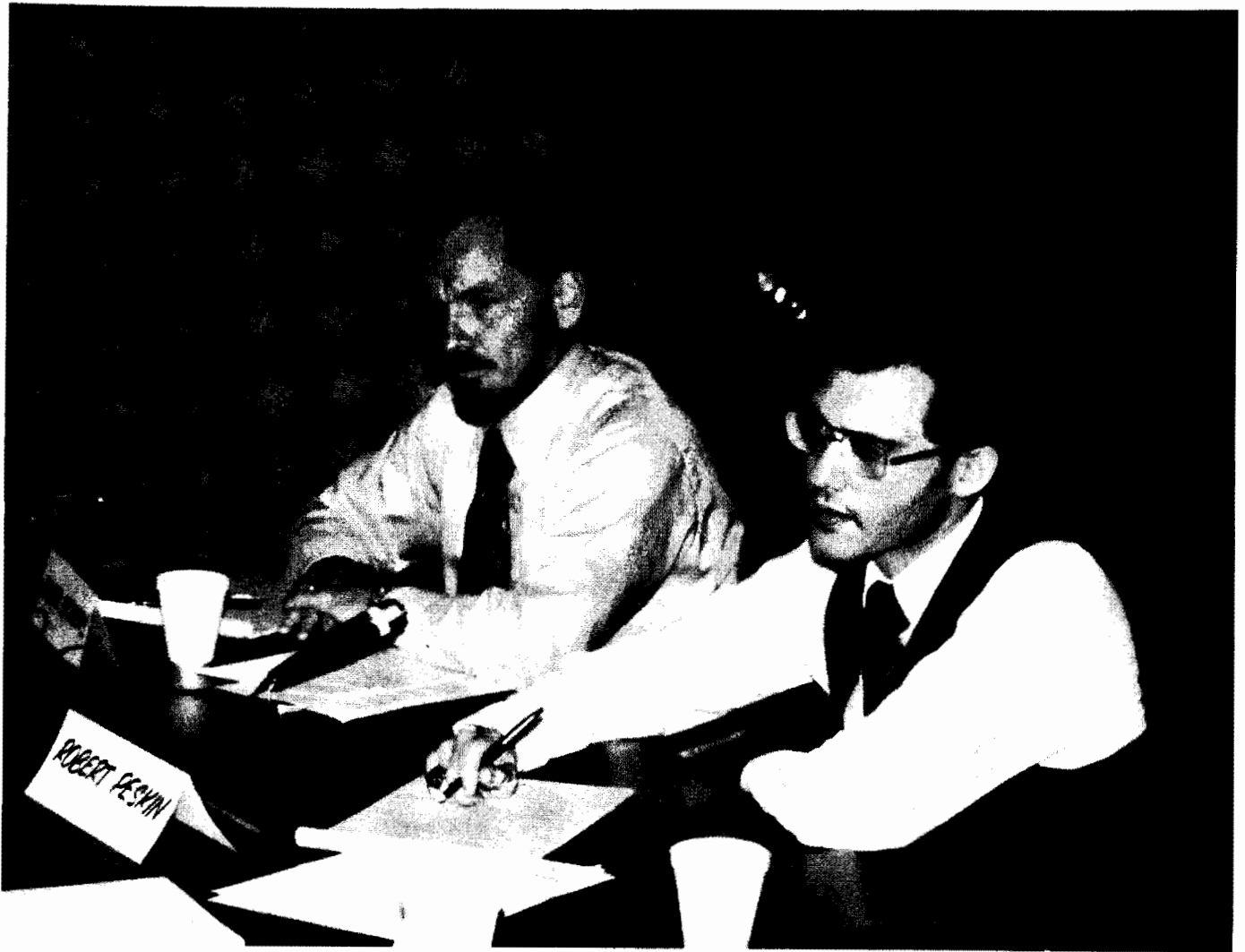
**MR. LASH:** The point is to involve the public. This will help bring to the surface some options that will be responsive to the public and also energy efficient.

**MR. HULTGREN:** Healthy skepticism is my attitude towards ridesharing. I think it is a good idea, we promote it, we work at it. But the vanpool, in my opinion, has kind of a limited market. You are really talking about long work trips, and there are not that many cities that have long work trips.

I would like to see an analysis of families that have one or more people ridesharing and families that don't participate in any kind of ridesharing activities. Look at their number of trips per household, and look at their average VMT per household, and see if they differ. I would like to believe they are different, but we know that the car left home gets used, and we don't know how much.

**DR. HARTGEN:** Well, about 40 percent of what you save would be lost. About 40 percent of the savings on that work trip gets nibbled away by additional nonwork travel. Now, is that good or bad? It is mobility; you are still gaining 60 percent, and the increased mobility is probably worth the other 40 percent.

**MR. HEANUE:** I think it is also well to emphasize some of the resources available to implement ridesharing. Too often, public works officials think in terms of construction projects. But Federal and State laws now permit ridesharing and many TSM improvements to compete equally with traditional capital facilities. I don't think we have educated either elected officials or



many planners to that fact.

One thing we haven't heard discussed here is the improvement to existing signal systems. In terms of cost effectiveness, if you can prevent relatively small numbers of vehicles from being unnecessarily stopped by making signals traffic-actuated, the savings are absolutely enormous. The investment to achieve this efficiency is four times more effective than ridesharing and 40 times more effective than transit investment. It is one of the easiest things a transportation planner and traffic engineer can do to save some energy.

**DR. PESKIN:** Discontinuity in the highway system is helping the energy situation in one sense because it imposes a very large impedance to travel and may be, indeed, eliminating trips if congestion is quite severe. This seems to be the type of problem that is difficult to generalize. Certainly, what peak period travel does exist is very energy inefficient due to the congestion. But once you open it up, you are going to encourage a lot more traffic.

**DR. HARTGEN:** There have been a couple of studies done on the question of VMT induced by

new highways. One suggested that about half of the VMT's generated by a gap-closing facility wouldn't have been generated at all had the facility not been built.

You take that as an energy cost. You also have the energy cost required to construct the facility in the first place, and add that. You then look at the change in the travel patterns that result from the action.

I am not at all confident that the overall energy impact of a gap-closing action would come out positive or negative. I am just not confident enough to make generalizations.

**MR. SHIRLEY:** Most gap closures relieve congestion or inefficient travel because traffic before the gap closure has to go through a series of stop signs and so forth.

**DR. HARTGEN:** I was accounting for that. It is not clear to me that gap closures are energy efficient. The question seems moot, because it doesn't seem likely to me that gap-closing actions which were prevented in the past would now be viable on the basis of energy savings.

They might even be less viable, given the constraints on travel generally and the high cost of gasoline.

**MR. HULTGREN:** Our analysis always shows that our gap closures are good things. We always show energy savings. I think when you go out and build a new eight-lane Interstate freeway or a major new facility, then you have got to be careful. But most of the gap closures we have are really just relieving arterial traffic on another street. Politically they are worth it.

**MR. HEANUE:** You are accommodating growth that probably occurred 15 years ago.

**MR. HULTGREN:** Yes, most of these are within existing built-up areas.

**MR. LASH:** A concept you frequently hear expressed is that, to conserve energy, an urban transportation program should emphasize mass transit. Is this argument valid?

**DR. PESKIN:** For the very largest cities, transit seems to be playing a major role. It is pulling a portion of travel off of the highway network, travel which would otherwise cause crushing congestion. Transit is not for all cities, but for the top 20 or so and perhaps in certain corridors in other cities it plays a vital role, and high levels of service should be maintained.

We shouldn't be shortsighted and say that the current service provided will be satisfactory in the future. We have to consider where new urban growth will occur. There are many cases where improvements in public transportation will have to be made just to maintain current conditions. If not done, the result will be increasing congestion on the highway network and resulting energy inefficiencies. But that is not the case nationwide. You can't extend the situation in the larger cities to all urbanized areas, and Federal and local policy should reflect that.

**DR. HARTGEN:** I agree with Bob. Transit in the larger cities is the first line of defense against the deterioration of the density investments and the investments in high-quality energy efficiency previously made. New York City is the most energy-efficient city in the country, transportation-wise, and the transit system in New York City permits that. We have calculated that if you took that system away, and those people drove like they do in, say, Colorado, we would have an immediate oil shortfall twice that caused by the Iranian revolution.

**MR. HEANUE:** Dave, what are the orders of magnitude? Can you give us some numbers for an efficient State?

**DR. HARTGEN:** As I recall my averages, New York State consumes about 500 or 600 gallons per capita per year of gasoline. The national average is in the range of 800 gallons. Wyoming I think is the worst State, which is in the range of 1100 gallons. They have long trip lengths, lots of pickup trucks, and, of course, less dense places.

The point of all this is, if you have high density and a transportation system that enables this urban structure to exist, you are very foolish to permit that density system to deteriorate. Every person you prevent from diverting from transit is 300 gallons a year of gasoline that would otherwise be lost. Gasoline saved in New York is gasoline available for Maine or for Wyoming. We are all in this boat together and ought, therefore, to support those existing good transit systems.

But it doesn't necessarily follow that you should build such systems in places which presently don't have them. The backwards diversion to transit is not nearly as great; thus investments made in new transit will not save the energy that investments made in existing transit would save. The two sides of the coin are not the same.

**MR. HEANUE:** You reach a point, like in Houston perhaps or San Francisco 15 years ago, where if you are going to continue to grow and there is no space for freeways, you have to invest in a transit system to permit that growth to occur.

**DR. HARTGEN:** That's right, but I am not sure that we will see a large push now on heavy or even light fixed guideway transit investment. There are many other alternative transit forms available and these ought to be explored fully for any future corridors.

**MR. SHACKSON:** This leads us to a dilemma which potentially is faced by the transportation planner. I would take strong exception to the assertion that the objectives of near-term contingency planning for short fuel supply interruptions are consistent with the objectives of longer term energy productivity.

For example, in a small community where a careful assessment would say it isn't good to move toward mass transit to improve energy efficiency in the long term, the planner still may find himself under pressure to implement some mass transit for energy contingency reasons. That may be a perfectly valid objective. But it needs to be separated from the objective of long-term efficiency improvement.



**DR. DIFIGLIO:** I would like local planners to reexamine their current rail transit plans. Unlike the electric vehicle, rail transit requires electrical capacity at its peak. The percentage of oil used during the peak is much higher than average, and the marginal cost of electricity during this peak is enormously higher than average. When you look at the restrictions of both heavy and light rail transit in terms of flexibility, the potential of new concepts like paratransit, and the tax liabilities required to support rail systems, it becomes apparent that buses would provide comparable levels of service for far lower cost, both for the user and the taxpayer. From the standpoint of getting people out of their cars, this type of service could save much more energy than fixed rail transit.

I am not objecting to fixed rail transit from the standpoint of its ability to revitalize an urban area. But the energy consumption impacts of revitalizing an urban area through rail transit may be very high. I see much more energy savings coming from commuter oriented programs like buses on exclusive rights-of-way that divert people out of their cars with faster travel times from home to work.

**MR. HULTGREN:** Buses have no political pizzazz. They are here today, gone tomorrow. We are building a light rail line in a corridor that has two Interstate freeways, neither of which is at capacity. One is operating at about half of its capacity. We could have put free flow buses or an HOV lane on the freeways, but a light rail line was wanted instead.

**DR. HARTGEN:** New York has trouble finding the subsidy money to keep its existing system operating, while other cities are up to their ears in transit subsidy money.

**MR. HULTGREN:** When you look at the energy efficiency of buses, you are really looking at the productivity on your routes. We have a passenger counting program and calculate passenger miles per gallon for every run on every route. Some routes do 5 passenger-miles-per-gallon and other routes do 50. It is the productive routes that are having the energy impact. You get the productive routes in the larger cities where you have the densities.

**DR. HARTGEN:** Some of your riders, then, are cross-subsidizing service for other riders, which raises some questions about equity.

**MR. HULTGREN:** In a lot of smaller cities Federal funds provide more service and spread it out. That is probably consuming energy, particularly the rural transit services. Now, that's nice and it is providing a minimum level of mobility, but to be honest, it is wasting energy.

We have some new articulated buses in San Diego that get about 2.2 miles-per-gallon. On the heavier routes where they are operating, they get about 35 passenger miles-per-gallon. Those buses are pretty heavily utilized in their in-bound peak. When they are out-bound, they are empty, and there is no way you can get them full.

Our transit system is getting about 50 passenger-miles-per-gallon right now. New buses get poor gas mileage, and they are going to be around for 15 years, but since we are not going to replace our old stock let's say we can maintain the 50 passenger-miles-per-gallon. Ten years from now automobiles with an average occupancy of 1.5 are going to be averaging 40 passenger-miles-per-gallon. Keeping in mind the circuitry in transit routing, are we much better off in transit?

I don't think we are going in the right direction with our bus systems. At least we should be moving towards an energy efficient bus.

**MR. JAMIESON:** I would like to see a good, gutsy transportation planner in a medium-sized city take the central area of the city which has potential some day for a fixed guideway system and say, "Okay, we can't afford it today, but in the future there will be stations here, here, and here." That would help the far-sighted developers that really want to locate on those spots. Developers are getting burned by being in the wrong places at the wrong time. Why not give those with foresight an opportunity to locate near future rail transit stations? It doesn't cost you a penny.

Also, in outer suburbia the same individual should examine the area beyond the practical limits for bus service, what we could call "paratransit territory." He should show the public how they could rideshare in various ways. On a map he should indicate the outer limits of bus services with various subsidies, then sit down with local officials and discuss the realistic future for bus transportation within those areas.

It would be very healthy for people and developers in outer suburbia to know that paratransit is all they are going to get. We have a lot of people living there that are still trolley-jollies, who expect somebody to come out there with some fixed guideway or bus system. Let's face it; we should set forth the ultimate possibilities, then start to work on clustering development in the inner suburban areas that will permit a higher level of transit service.

What has hurt the bus business is that passengers-per-bus-mile have been dropping as urban development has been spreading out.

**MR. SHACKSON:** I think we are saying that there are probably lots of good reasons for considering implementation of transit extensions, but seldom will energy be at the top. The transportation planner really is balancing the need for transit for other reasons against what may be some negative impacts of transit.



**DR. DIFIGLIO:** The only way public transportation is going to divert an auto driver to public transportation, except in a gas crisis, is to offer a travel time advantage. Unless public transportation can offer competitive service to the automobile, all it is going to do is induce new travel. Despite congestion and all the problems of automobile travel, in most corridors it is still the fastest way to work.

The highway system is provided to people free. Everybody can take a vehicle and use up his amount of the road out of proportion to either his economic contribution to the roadway or his need to use that roadway. Just being first in line is the only criterion.

During the gasoline crisis, all of us could look at the lines and say, "How horrible. We cannot permit this. Motors are idling; fuel is being wasted. We have to figure out something else, maybe the market—maybe some kind of rationing." People were appalled to sit at the gas station for an hour.

Yet nobody is appalled that people have to sit in line to get to work. A 20-minute drive takes an hour, but because we are so used to waiting our turn on the roadway we are opposed to treating it as an economic resource that we purchase and use. The only way to really eliminate the transportation problem is to eliminate free transportation.

**DR. HARTGEN:** I agree with a great deal you say, but I must take issue with the first point, that travel time savings are the major factor behind transit usage. There is a great deal of evidence, both empirical and otherwise, which suggests that precisely the opposite is true. Individuals are induced to use high-quality transit services on the basis of their comfort and convenience, often incurring increases in travel time in exchange for comfort, convenience, and privacy at a very high cost.

I don't think that we will be able to get transit out of its present position by simply making it faster. We are going to have to make it more responsive, more comfortable, more private, more convenient, and more in tune with the rider's perception of himself.

This is a case by case kind of problem. Some express bus services from New Jersey, New York, and Connecticut into the center of New York City operate far more slowly than do parallel services—for instance, commuter trains and the subway. Yet they are heavily patronized. They can't find enough operators and vehicles to provide the services.

**DR. STOWERS:** I want to second John's appeal for a return to old-fashioned, long-range planning. We ought to reserve rights-of-way; we ought to look farther into the future.

In the Federal programs we have backed away from that. UMTA has said, "We will only take it bit by bit and piece by piece; we won't reserve rights-of-way; we won't endorse any long range plans." I don't think the highway programs have done anything to encourage reservation of rights-of-way for transit. In parts of growing metropolitan areas there are a lot of opportunities to do that. But you really have to have a plan and you have to tie in with land use. I don't think local or State or Federal governments are doing as much as they were 20 years ago.

**MR. LASH:** As ironic as it may seem, the environmental movement has made it difficult to do long-range planning; ironic because long-range planning is intended to build better environments. The environmental impact statement process makes it difficult to prepare long-range plans and make long-range commitments.

Carmen brought up something that I wish he would complete. I think he made an important statement when he said that the automobile shouldn't use the road free of charge. If you were going to do something about that as a transportation planner, how would you go about it?

**DR. DIFIGLIO:** In Singapore, where government control is accepted with more equanimity than it is in this country, they have a sticker program in the central area of the city—you buy that sticker either on a monthly or a daily basis. Experiments showed that single-occupancy cars dropped to a quarter of their former use, total auto traffic dropped to 40 percent, and public transportation increased 15 percent, which is large because the majority of Singaporeans already went to work on public transportation. Public transportation performance increased by about 30 to 40 percent in terms of travel times.

In the United States, there is a bias against using a price system for the roadway, so we must use proxies. The best proxies we have for roadway charges would be parking charges and exclusive use of roadway space for high occupancy vehicles. A combination of increasing parking charges and providing special access privileges to high occupancy vehicles could bring about the kind of changes that a roadway pricing system would—the elimination of congestion.

**DR. HARTGEN:** Singapore is at the end of a peninsula and there is no hinterland community that otherwise would have rapidly grown when Singapore instituted this process. Also, traffic is eliminated only during the peak hours. The area on the fringe is incredibly congested until 9:30 a.m. when the "green light" goes on. Traffic has fallen 40 percent, but that is just within this small, central area.

In the United States, the immediate reaction would be helter-skelter growth of the suburbs to the eventual detriment, and probably the demise, of downtown areas. It would further accelerate the spread and sprawl of the city. Except for a few such places that are equally constrained, I don't know of any places where that would work in this country.

**DR. DIFIGLIO:** I cannot accept the concept that transportation on a pay-as-you-go basis is in any sense disadvantageous to central areas.

**DR. HARTGEN:** I didn't say that. I am concerned about the idea of a stringent, stick approach. We talked earlier about the effectiveness of vehicle improvements and transit alternatives. Why do we need sticks given the options that we have?

**DR. STOWERS:** Carmen, you acknowledged that, in general, what you were talking about in Singapore was politically unfeasible here. San Francisco meets the criteria that you described for Singapore as much as any city. They raised the price of parking by 25 percent and that only lasted a few weeks.

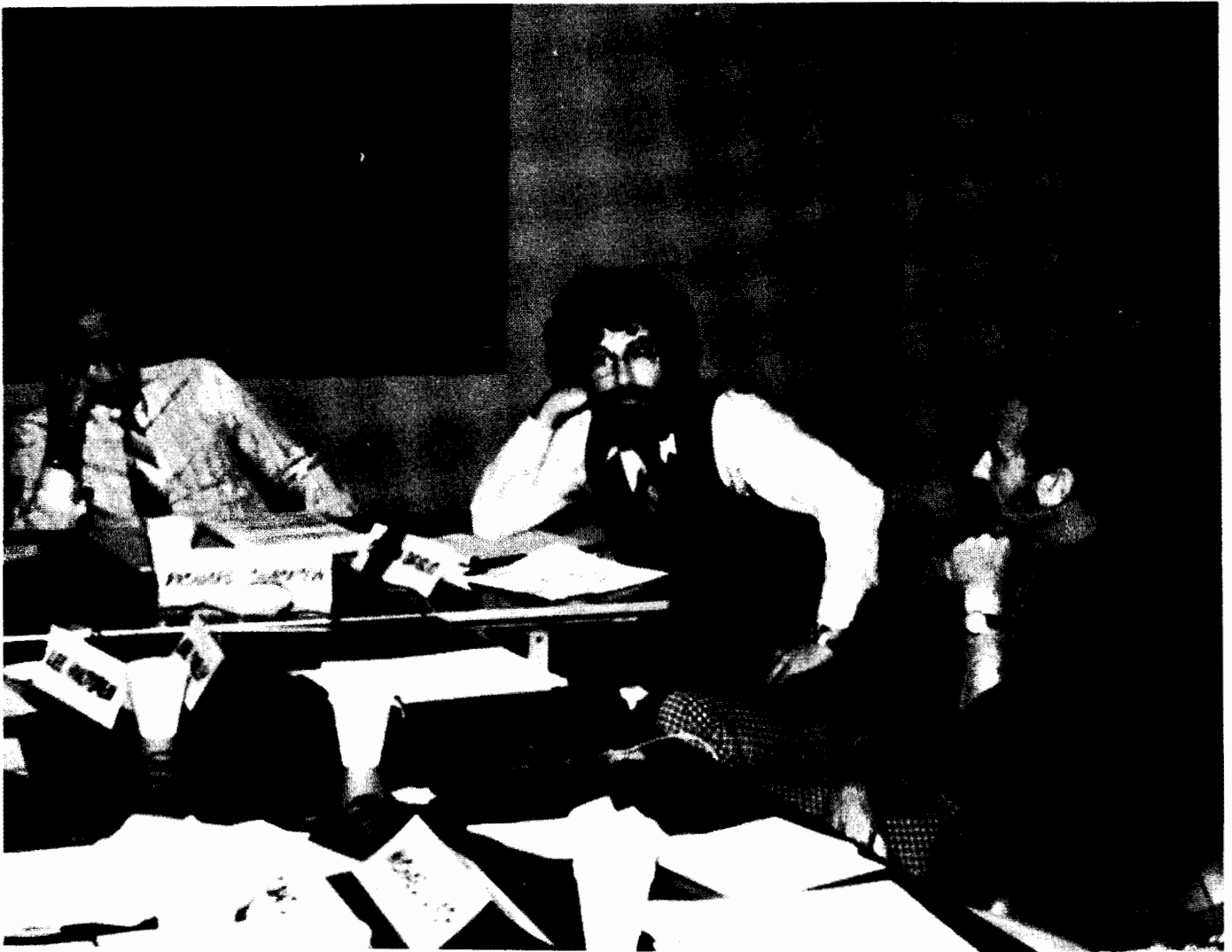
**MR. HEANUE:** I don't think we should be too quick to reject such ideas. John Kain, head of the Planning Department at Harvard, described some analyses they did in downtown Boston, which fits the same geographic description. A permit parking system for residents only, eliminating other parking entirely in the peak periods and permitting only short-term parking through mid-day, would give something like a 20 percent increase in level of service. It would cost about \$2.00 per permit to administer the system.

It was Dr. Kain's observation that planners are just too quick to reject innovative ideas, which thus never make it to the elected officials, some of whom really want to experiment.

**DR. HARTGEN:** Federal appeals for auto-restricted zones a few years ago attracted only three cities, even to the planning stage. The political hurdles are very, very substantial.

**MR. HEANUE:** But permit systems are growing. The Supreme Court validated them only 5 years ago, and there has been an enormous utilization since that time. You will see a lot more.





**MR. SHACKSON:** Let me make the outrageous suggestion that congestion is a welcome phenomenon, and probably a much more elegant road pricing scheme than Carmen or any other bureaucrat in his wildest dreams could imagine. The elimination of congestion as an objective is something that has been talked about ever since I have had any exposure to transportation. All we succeed in doing is to relocate the congestion elsewhere on the network.

**DR. DIFIGLIO:** Twenty five years ago, the traditional effort to eliminate congestion was to build more highway capacity. Because the transportation planning models were somewhat insensitive to the impact that new highway capacity would have on travel, there was a misguided belief that building new capacity would eliminate congestion. But any economist 25 or 30 years ago could have told the traffic engineer that congestion isn't going to be eliminated; your model here is mistaken; the trip generation equation doesn't have any highway capacity in it.

If you build new capacity, you attract travel and congestion; it's an unending characteristic of any highway system that offers good service in an urban area. As long as the highway system is

available to all during peak periods, industries and housing will locate in such a way that the system is used to congestion capacity, until people are no longer willing to wait in line.

I want economic restrictions on travel which, in effect, account for the full cost of capacity in peak periods. That cost is not the historical cost of building the road, but the opportunity cost of getting to work in some other way. If people can accept the concept that they should bid for TV sets or any other commodity, if they believe that the market process produces an efficient distribution of goods and resources and provides people what they want, why should they say the transportation sector has to be free?

**DR. HARTGEN:** It has always amazed me how the Energy Department can on one hand suggest controls for transportation and, at the same time, advocate a free market environment for other energy source supply and demand issues.

I know of only limited evidence suggesting that highway investment and accessibility increases induce traffic. I know of no city which has empirically demonstrated traffic increases beyond the growth that would have occurred by population, and households, and cars.

**DR. DIFIGLIO:** If you have the proper model specification, you can show a relationship between capacity and demand. I think the mere existence of current congestion levels on highway systems that were planned 20 to 25 years ago, which were forecasted to have no congestion, strongly suggests that building more highway capacity does not eliminate congestion.

**DR. HARTGEN:** Carmen, had they not been built the congestion would be there. What is the difference?

**DR. DIFIGLIO:** Exactly. As long as the system is free, congestion will be there. It doesn't matter how much capacity you build.

**DR. HARTGEN:** If the system were not free, the congestion would be on the free parts. It just gets moved around as in the Singapore case. If it cannot be moved around geographically, it will be moved in time.

**DR. DIFIGLIO:** A sophisticated pricing system would have pricing everywhere, and pricing would be continuously and systematically based on congestion.

**DR. HARTGEN:** This is all theory. We are talking about practical actions here.

**MR. LASH:** In your opening comments, many of you expressed a desire to present options to consumers so they can make transportation choices that would also lead to energy conservation. As we move on into the day, I hear more and more statements urging the restriction of consumer choices. Carmen, I sense a lot that you say reflects an attitude of forcing people to do certain things because you feel that is the best thing for them to do.

That may be necessary. I am not saying it isn't. But still I would like to see if we can satisfy the goal of government in a free society of providing options for people to maximize social benefits, and at the same time achieve some necessary goals such as conservation of petroleum. Those are two very, very worthy goals. I am really puzzled as to how we can blend these two worthy goals together.

**DR. DIFIGLIO:** By looking at free choice versus forcing, we immediately misstate our tradeoffs. Any application of economic resources is going to result in a use pattern. I am suggesting that patterns of use, governed by congestion, are less efficient than patterns of use governed by a price system or a proxy to a price system. There is just as much choice in allowing a person to make an uncongested trip at an economic cost as there is in allowing him to

make a trip into the city only under conditions of congestion. I don't see that much choice in the current system. The only way to go to work downtown is to wait in line and crawl along to the central core area.

While public transportation provides an alternative, often the amenities and the characteristics of that system discourage many people. Public transportation still doesn't provide enough good service to compete with the private automobile.

Changing the way we use our transportation system can be viewed as a way of giving people more choices. However, we all tend to be more comfortable with what exists rather than what could be. It sounds like forced change. But that doesn't necessarily mean a less desirable set of alternatives.

**DR. STOWERS:** I would like to back up 100 percent what Carmen is saying. In engineering terms, you see it in the curves of how volumes and speeds perform on highways. You build up traffic to a certain level and everything just breaks down. When you get to that margin, you create enormous social costs in terms of congestion for the whole system.

The system ought to back off from the level of congestion to where it is operating efficiently. You can come close to a free market situation is what Carmen is saying. If there is a market for that space on the highway, the right price would determine the most efficient solution. We don't have a market, and we politically and technically haven't been able to establish that, but you can come close to it by ramp metering. Everywhere it has been done, it works pretty well.

I agree with Carmen. It is improving the situation for everybody. It is providing more freedom of choice; it is freeing up congestion.

**DR. HARTGEN:** Don't you think it will take a while before an individual driving alone in his Coup de Ville could pay \$4.00 and use the HOV lane on the Shirley Highway?

**DR. STOWERS:** We are talking on theoretical grounds when we talk about perfect pricing systems. We are just not going to institute what Singapore did or go beyond that to a theoretical, optimal system. In a theoretically perfect free market that is what you would do, yes.

## How Might Transportation Help Encourage Energy Efficient Land Use?

**MR. LASH:** Let's turn to the question of land use. Is it clear what pattern of metropolitan area development is most energy efficient? And to what extent can we as transportation people make decisions that might promote energy efficient land use patterns?

**DR. PESKIN:** I don't think we have enough evidence in yet to say that it is clear. However, there is a lot of theoretical evidence that indicates that polynucleated cities are very energy efficient. A polynucleated city would involve, say, a major employment center and surrounding residential areas, surrounded by several smaller employment centers with residential areas surrounding them.

There are some indications that a lot of recent urban growth has, in effect, resulted in polynucleated cities. They may not look like polynucleated cities, but the travel is characteristic. A lot of people are now living in the suburbs and are traveling to employment locations relatively closer to their homes.

My research has shown that policy decisions that would tend to coordinate development of the transportation network with the direction in which suburban growth is moving would tend to be more energy efficient, but I think there still remains a lot of work to be done.

**DR. STOWERS:** I agree with Bob. You are talking about balancing shopping, jobs, and housing to maximize the opportunity for short trips.

**MR. SHACKSON:** We have to be careful, though, just looking at how the polynucleated city affects vehicle miles of travel. The short, cold-start trip is the one that really gobbles the fuel. If travel demand consists of unlinked, cold-start trips, it is disastrous for energy consumption, and for air quality as well.

**DR. STOWERS:** You want not only polynucleated cities on the metropolitan scale, but at a finer grain you want multipurpose development to maximize the opportunity for non-vehicular trips. The opposite extreme of this is to pile up single-purpose uses in one location like Manhattan, or huge shopping centers near freeway interchanges. If you provide enormous capacity, you will get the possibility of very large scale development and very long trips.

**MR. LASH:** Is some special type of control needed to bring about polynucleated cities and multipurpose development? Or is this already happening naturally?

**DR. STOWERS:** If you've got congestion, it will happen. Congestion causes things to spread out; it's happening all over America where congestion levels have increased. You achieve these urban forms not by planning congestion, but by planning land use and transportation and by putting your transportation money into plans that bring about a balance at both the metropolitan and local scales.

**MR. SHIRLEY:** You can't just consider the efficiency of transportation when you are talking about land use planning. You have got to look at all the other elements of the infrastructure and their use of energy.

Looking at Southern California, the logical person would assume that there wasn't enough water for further growth. But given the population to swing a vote, you can import water at great energy cost and fly in the face of logic and reason. I don't hold much hope for land use planning being accepted politically, especially if it is forced.

I feel very strongly about reserving agricultural land. I am disturbed about our position internationally. Any development that would use prime

agricultural land and force us to farm second-rate land, use more petrochemical fertilizer, and import water is irrational.

**MR. HEANUE:** I am very pessimistic that land use can do much to improve the transportation energy situation. Our older Eastern cities, because of increasing affluence and decreasing family size, are losing population fast. We have got to do everything we can to make in-fill development efficient. But we can't begin to compensate for the losses that have already occurred and will continue to occur. The country as a whole isn't going to have that fast of a growth rate. The Sunbelt cities will grow. But those are the ones least inclined to accept high density and the things that make transportation efficient. You have very serious problems at both ends of the scale. We have to do all we can, but I am not optimistic for much improvement.

I have got to respond to the view that highways induce growth. I don't know of anyone who is building highways out to vacant land to get ahead of development. Across the country, the Interstate System opened up land coincidentally at rural interchanges. Beyond that, we are 15 years late getting needed capacity to serve development.

**DR. STOWERS:** That is the kind of thing that I am talking about, Kevin. Scattered site development occurs way out at the edge of every metropolitan area in the country because the land is cheap. As a result, people drive exceptionally long distances; there is no public transportation service. This is the worst energy consumption situation. We then follow along and provide the highway capacity after the development happens. That is where most of the Federal dollars are going.

The transportation and urban planner has to recognize that we are extremely wasteful in the way we allow urban development to take place. The consumer purchasing a cheap house 20 miles away from his job site is not the source of the problem. The way we deal with the economics of development in terms of government policy really tends to encourage excessive driving because really there is a big subsidy for scattered development. The individual making a decision is, in effect, getting subsidized to live in a remote location where it is less efficient. Based on one example situation, I would say that the subsidy is something on the order of about \$1500 per dwelling unit for the transportation cost associated with scattered-site homes versus in-filling in developed areas, all based on Federal transportation policy.

**DR. HARTGEN:** I don't understand what is wrong with those values. If Bob Peskin is right and the 1980 census shows that in fact our preconceived notions about trip lengths are not true, that in fact cities have been growing in ways which are quite different than we believe, why not encourage growth at the fringe if that growth adds nothing to the average trip length and trip rate?

**DR. STOWERS:** I am talking about the fringe now, and not about density. I am talking about scattered development on individual sites remote from the metropolitan area. If somebody wants to buy a house on a scattered-site basis, he ought to be paying the full cost of it, and our policies ought to work toward that objective. Whether you are talking about sewers or water or police or schools or anything like that, they are cheaper if you have contiguous development.

**DR. HARTGEN:** I'm not sure we know the full cost of the house in the dense area where the individual has to pay for crime, police protection, and a host of other services that come with the environment. Once again, we as planners have missed entirely the direction of the public in this area. True, the public is moving out so cities are expanding, but this does not mean that a subsidy exists.

Energy is only one factor that people consider when buying houses. It has not, until recently, even been a major factor. I am not sure it is now. I can easily buy a house in the suburbs and trade in a 10-mile-a-gallon pig for a 30-mile-a-gallon Rabbit and be ahead on all fronts. I'd be paying less out-of-pocket for gas, have a nicer environment, own a cheaper house on a bigger lot, have pleasant schools, and my wife wouldn't have to worry about getting raped on the way to the subway or whatever.

Why shouldn't the individual consumer behave rationally and pick that choice? In fact, he does. And I am not at all convinced that there is a tradeoff here at all for the consumer.

**DR. STOWERS:** Wait a minute, now. I wasn't comparing living in a new development that is planned on the fringes with city living; that is not the issue here. The issue is what kind of new development occurs. Because of the subsidies that are inherent in our policies, development occurs not in a contiguous manner, but to a very great extent on a scattered-site basis, which is very energy inefficient. It results in the most inefficient transportation investment when it comes to the highway program.



**DR. HARTGEN:** I can see your point. In-fill development is probably better than scattered-site. But I am very concerned about leaving our readers with the thought that urban-type living patterns are inherently superior. I think we should not say that.

**DR. STOWERS:** I am talking about contiguous development and that only. When you have contiguous development you have the possibility for short trips.

**MR. JAMIESON:** There is also the matter of job sites moving out and not being located in an efficient way. Recently, we were looking at a very large industrial complex being located in an eastern State, away from public transportation, away from the urban centers. The calculations came out that by the year 2000 it would take 5 million more gallons of gasoline a year to service the complex than it would take had it been located in the industrial areas. I think we should have more energy statistics on this type of scattered development.

**MR. SEAWELL:** I think suburbia and the workplace have some psychological importance. People like to leave home, go to work, flirt with

the male or female counterpart that they work with, and have a fantasy life away from the family. Then they like to come home to be responsible Episcopalians or Presbyterians or Catholics or whatever. They are back in their neighborhood and a pillar of that society, and that 20 mile dichotomy between where they live and where they work is something that is going to take a long time to go away.

I think people like that dichotomy very much. And with no moral judgment made on it, Americans are going to try to persevere it because we like both parts of our lives. And a good way to do so is to put distance between the two places.

**MR. SHACKSON:** We have to expand our horizons and consider development patterns that we haven't yet experienced. They may offer opportunities, and not only from an energy standpoint. I don't know how I would respond to living in a megastructure with a couple of million people per square mile. There are some things that are very attractive about that form of living, and there have been waves of interest in such things. But in the longer range, there are options at density extremes that we are not considering in our day-to-day research that we shouldn't forget.



**MR. LASH:** To what extent do transportation plans influence the form of urban development, and can we use transportation improvements to shape urban development in more efficient energy patterns? Should this be a factor in deciding on urban transportation improvement programs?

**MR. HEANUE:** It's probably a little late. In most areas we are really out of the period of big investments in transportation infrastructure of a magnitude that could significantly influence land use. I think that things will occur at the corridor level, at interchanges, and around transit stations. Maybe some areas will be lucky enough to begin to preserve rights-of-way for future facilities. The average transportation planner has got to focus more on operation, getting the best out of the existing system and making a very judicious use of investments.

**DR. STOWERS:** We still want to put our transportation infrastructure investment into fostering development that will be energy efficient by creating short trips. The only way now you get large-scale, clustered, multipurpose development is if the developer has to put in all of the infrastructure for that development; no public monies go into that right now. In effect, you essentially have a tax against that form of development.

I'd put transportation money into the infrastructure of development which is energy efficient, into multipurpose development in the right locations served by the right transportation facilities. Federal and State monies ought to provide a portion of the transportation infrastructure of developments that satisfy the energy efficiency criteria that we probably all agree upon.

**DR. DIFIGLIO:** I am not sure that behavior would be that much different.

**DR. STOWERS:** I would be satisfied, Carmen, for the transportation program to be neutral.

**DR. DIFIGLIO:** The increase in housing prices—the inflation of material and labor have driven the price of a house up enormously—has not changed behavior. The popularity of the detached house has not diminished. It is hard to believe that if developers had to pay the full cost that their economic behavior would be any different. They would face the same demand, and development patterns would be no different.

I think there are a lot of cities where the transportation structure is already built, and these cities are not going to grow. On the other hand, a lot of the Sunbelt cities are going to be growing tremendously in the next 10 years. I think there is

an avenue in those locations to perhaps institute some of these things.

**MR. SEAWELL:** On the low estimate, Colorado will get a million people by the end of the century. Transportation can be the means to shape where that growth takes place. It is difficult for the transportation planner to influence development patterns because the money for transportation doesn't relate directly to how a planning commission in a county will decide where streets go within a neighborhood. But just putting a street so that the access to the building faces the south side for passive solar benefits has a tremendous energy impact. Often we find that the big corridors almost set up situations where the small feeder streets can't get in the right wind and sun perspective for building efficient energy use in the house. Those kinds of things have got to be worked on, and not only by transportation planners alone.

**DR. STOWERS:** A specific thing that can be done is not to approve development plans unless the area is served by transit. That is done in Oregon right now.

**DR. HARTGEN:** Well, that is a major policy statement. Many States would not be willing to go that far, given the subsequent cost of providing transit in the lowest density, most rapidly developing areas.

**MR. HEANUE:** I really fear for the Federal Government to tread into that area. We have a hierarchy, with Federal interest in the major systems. I think you are talking about design issues, subdivision controls at the local, perhaps regional or State level, and I just don't see that it is appropriate for Federal policy or Federal subsidy.

**MR. SEAWELL:** The Federal money is the people's money. I know the dangers you are talking about, but I worked on a water facility project where we used an EPA grant to see that there was rational planning of growth, land use, and water facilities. The EPA was not going to put in \$6 million for water treatment unless it got some growth control.

I think energy is as national an issue as pollution is. I don't see using Federal highway funds or transit funds in that kind of way as inappropriate at all.

**DR. HARTGEN:** It may be a question of communication here. I am not saying that Federal money should not be used to encourage that kind of development or growth if the local community perceives that it is in its best interest. The problem is in mandating, without flexibility at the local level.

There is great flexibility in the way that highway funds are now being allocated. Perhaps the perception in the field is that urban system funds are highway funds; they are well guarded by the municipal engineer and the county engineer. Some really look down on the use of these for carpooling, vanpooling, or bikeways, or even something for the pedestrian. But I think all the agencies should try to shore up some of these things that are energy efficient. While it has been a cost-saving thing not to worry about the sidewalk, we have to say, "Now look, we've got to get the people to the bus stop; we've got to take on that responsibility." Skyways or skywalks are also an excellent way to separate pedestrians and motor vehicles. If we don't step in and become the pedestrian advocate, we are missing a real chance.

**MR. JAMIESON:** I think one way we could encourage this is to get the transportation decisionmakers in joint venture with the land use decisionmakers. Presently the developer gets his zoning changed and then, after the fact, comes to the highway agency and says, "I need a highway access permit now. Hand it to me on a safe and reasonable basis. Don't give me any of this talk about land use planning." Instead, the transportation agencies that are ultimately issuing the access permits should be doing things up front, working with the local communities that are changing the zoning.

Our highway system is a resource that we have to start protecting. TSM just makes it operate more efficiently. We also need something you could call highway system information and management where we look at what capacity remains on different parts of this system and how it could be allocated to the users. We should work with the municipalities when they are developing their plans and show them the advantages of efficient development patterns. The tools are there. A lot of it is just providing good information back to the developers, showing them where highways are over capacity or where you are planning to increase transportation capacity.

I think that transportation programs should not be subsidizing extremely scattered development on the fringes of metropolitan areas, which is what they are doing right now.

**MR. SHACKSON:** We have a problem getting incentives in line here. The local transportation planner is fighting the need to serve present land use patterns and also to develop something that moves us in a better direction.

There was a point in our history where transportation infrastructure was built by granting land to railroad companies and then permitting

them to capitalize on the growth that their actions caused. Is there a way in which one can turn the developer into the provider of the transportation capital facility by permitting him somehow to participate in the consequences of the land use that his capital facility generates?

**DR. STOWERS:** Density could be one possibility; a developer could be granted an order of magnitude increase in density or some increment in return for certain kinds of transportation.

**MR. HULTGREN:** We used that with parking space. We also trade development rights for developer-provided facilities.

**MR. SHACKSON:** Yes, that is certainly getting there. What I was returning to was driving some stakes in the ground in high density areas and saying these are eventual nodes on a network, and say, "Okay, you can have a little parcel of land near this stake if you will participate in the capitalization."

**DR. STOWERS:** Another idea used by local government in my area and by some States is prepayment of taxes that go directly for transportation projects that are a necessary part of the development infrastructure.

**MR. HULTGREN:** In San Diego we tried to use projects to shape development some years ago. But we got a generally negative response from all of the cities. Most of them didn't want higher densities. In fact, when the Metropolitan Transit Development Board was promoting the guideway system, they were afraid that if they told the cities there would be higher densities around the stations they would oppose the guideway. We have found that people don't like the grand plans and high density around stations.

**MR. LASH:** Many of you are making the assumption that higher density usually means more energy efficient development. Yet there is a lot of public resistance to higher density. How do we deal with that and at the same time try to maximize freedom of public choice?

**MR. HULTGREN:** In the future, at least in San Diego, I think higher density is the only thing people will be able to afford. In-filling is happening right now, and we are getting higher density. People don't like it but it is all they can buy.

**MR. STOWERS:** Higher density is accepted in a new area where people don't already live. It's when it's in your own backyard that people object.

**MR. SHIRLEY:** We are seeing lots of changes in density in California cities due to the high price of housing. There is a change in attitude. But I still feel that, to get some of these things across, we need to condition the public through advertising campaigns. We aren't taking advantage of some of the Madison Avenue techniques.

**MR. HULTGREN:** I just don't think the public sector should be out trying to tell people how to live.

**DR. HARTGEN:** I have never seen a single product sold for very long that didn't have some characteristics that people wished to buy. If a product fits within a spectrum of products, then marketing is often the key to raising the public's consciousness of the product to the point where its differences will be recognized and thus it will sell.

If the product does not fit within the spectrum, no amount of advertising and marketing, no matter how slick, can save it.

**MR. SHIRLEY:** Yes, but I think our products have meaningful value.

**DR. HARTGEN:** I agree, and we probably have not sold them very well.

With respect to the specific question of what we might do, transit works well when high density office and commercial development is at one end of the service, and high density residential development is at the other end. But we all tend to worry about city growth and not density around stations, or we worry about station density and not whether there is anywhere for the people who live at those stations to go to once they get on the system. We can't deal with this problem in a fragmented manner. That means coordinated, long-range metropolitan planning, all of the things that we know are good. We just can't stop that now just because we have got an energy situation.

**DR. STOWERS:** One of the most important institutional mechanisms for bringing about integrated land development and transportation development is the development corporation. You have got to have a large-scale development authority that can integrate all development activity, including transportation. Right now local county governments don't have the kind of leverage to bring land use and transportation development together.

**DR. DIFIGLIO:** I feel that we are drifting from the energy impact of all this. We can understand, explain, and improve upon the way space is used around transit stations or expressway interchanges through cooperation among local governments, zoning councils, and transportation planners. But the real question is what impact

does transportation have on land use? Quite frankly, I don't think there is any answer to this question.

For example, building a rail transit system will certainly increase density and land values around subway stations. But it may also encourage people to move further out. The net energy impact could be efficient work travel and some increase in density around areas of high access balanced by nonwork travel that is less efficient. So you have pluses and minuses.

I think our analysis of the highway system is similarly confused, although with the highway system there is less on the plus side and more on the negative side. We can probably say that expansion of highway systems have led to increased energy consumption. But when it comes to the question of highway and transit tradeoffs, we are not in a very good position to recommend any formula for transportation development on the basis of land use impact because overall we probably don't know. I don't think we can use transportation planning as a way of influencing land use, simply because we don't know what the impact is.

**DR. STOWERS:** Carmen, you are saying the same thing that Kevin did. The only thing you have control over is where you put the money for big capital investments. Twenty years of history tell us that development programs have to be integrated, even if the programs are done purely through private investors and you just give them the money. You can't go it alone with transportation and get anywhere in shaping urban development patterns.

**DR. DIFIGLIO:** You are saying that we have to control land use development in such a way as to minimize energy consumption. But the transportation aspect of that is really an afterthought. The real political message here is "let's control development," which is a much more difficult thing than "let's influence our transportation decisions."

**DR. STOWERS:** But let's also put the transportation investment in a place and in a manner so that you get energy efficiency. You need to use every lever you can in a planned development program to achieve the kind of objectives we are addressing.

**MR. LASH:** Are you two proceeding from different assumptions? It seems to me that Carmen is saying we haven't any evidence to show how transportation improvements really shape urban development. Joe seems to be going beyond that, saying, "Well, that may be true, but really we can do other things. We can use this money in different ways. We might even give it to developers." He is now including other kinds of influences not normally a part of what is done in an urban area.



**DR. STOWERS:** I am talking about something that is quite radical, yes.

**MR. LASH:** Carmen is assuming we work within the present structure, and you are changing that structure. You are not conflicting with each other but saying different things.

**DR. STOWERS:** I think there is some misunderstanding. There is an assumption that transportation has been neutral when in fact transportation investments have been biased toward creating scattered site development. There has been an enormous subsidy, much of it from transportation programs, that has caused the most energy inefficient development patterns that exist anywhere in the world.

**DR. HARTGEN:** You have got very strong views about these things, but I just recoil when I hear words like "right" and "scattered growth" and when I hear a lot of "bads" being thrown out at this table. I don't think we as planners have any right to say what environment people should choose for themselves. Our job is to provide options, not to constrain.

**DR. STOWERS:** I agree, but if you are suspicious that your programs are creating subsidies for patterns that are inefficient from an energy standpoint, or other standpoints, then you should move in the direction of neutrality so that you are closer to the market situation where people can make choices freely with better awareness of the cost consequences.

**DR. HARTGEN:** Earlier we concluded that, while there was some evidence that multinucleated patterns are generally energy efficient, we don't have enough data to prove this is true. Now, Carmen is telling us another thing I think we generally agree with, that we really don't know how transportation and land use are inter-related or what kinds of transportation actions lead to efficient land use. We have some evidence on both extremes. But basically speaking, we don't know.

Now I am suggesting that, even if we did know, we are not directors of society. We are planners. Our job is to provide options through which mobility may be obtained at the same time that energy use may be constrained. That is the job, how to walk that middle line. I don't think it is particularly productive to say we have all got to go back to the caves, live in certain kinds of urban structures, or have certain kinds of transportation systems. These arguments are fruitless. The public is not listening to us. They will take the options which are easy.

**MR. HEANUE:** If I hear you right, Joe, you are asking for a direct developer subsidy to induce certain patterns of development. I think that can be accomplished within the police power, and it is something that belongs in a community development block grant program rather than a transportation program if it were to be federally funded.

Carmen, I think the state-of-the-art in transportation and land use modeling is a lot further along than you suggest. In the Washington area, the council of governments used a sophisticated land use model to test Metro systems of varying lengths. It concluded that a more clustered pattern of development would occur with a 41-mile transit system, which essentially didn't pierce the Beltway. A 100-mile system pierces the congestion barrier and induces low-density development.

The elected officials had the results and chose to go with the full 100-mile system because it brought all the surrounding jurisdictions into the financing pattern. That overrode every other consideration.

The analytical capability was there, and it exists in other cities. It doesn't come cheap, but if you want to invest the resources, it can be done.



## What Energy Assessment Techniques Should Be Used To Compare Transportation Alternatives?

**MR. LASH:** Let's now discuss energy assessment methodologies. Do transportation people now have the tools to make energy studies, so they can make decisions based on local conditions? What kind of tools do we have, and how can we best utilize them?

**DR. STOWERS:** About 2 years ago the Congressional Budget Office issued a report called "Urban Transportation and Energy: The Potential Savings of Different Modes." It was based upon a methodology, basically an accounting system, that took account of mode of access, circuitry of travel, manufacturing energy, construction energy, and operating energy. Every item you can think of is in there.

A lot of people had problems with the parameters. Everybody thought they were biased against transit. My firm has done a lot more surveying of all the parameter values. We did a fair amount of sensitivity analysis on every factor I mentioned and a lot of others, and looked at induced travel and a lot of other relationships that have to be taken into account. Our report, just now being published, is called "Urban Public Transportation and Energy."

There is a workable methodology there.

**DR. DIFGLIO:** I would second that. I think it is an excellent methodology, irrespective of which way you go on the numbers. To the extent that local people can duplicate that methodology, using energy efficiency factors for their specific area, they would go a long way toward improving the analyses they are doing.

**MR. HULTGREN:** Joe, were your findings significantly different from the Congressional Budget Office's findings?

**DR. STOWERS:** We tried to emphasize that you have to look at particular circumstances. The CBO tried to make sweeping national conclusions about what modes we ought to invest in. Also, we used numbers for the comparative efficiency of different modes that are different from the CBO's.

If anything, express bus systems were found even more attractive. I would say transit comes out looking a little better because we compared transit in corridors with higher density, and where automobile congestion is higher, so transit looks better in comparison to the market area it serves.

**MR. JAMIESON:** In doing planning, we try to minimize the debate between different modes. There is such a range of uses for these modes that debate isn't very productive and it gets quite confusing to the public. But when you are making transportation decisions, you need to examine what you are doing to the other modes so that you can look at the total picture.

For example, if you can put in a series of transit stations in such a way that you cluster development, then you in turn develop a lot of pedestrian trips. These are, compared to their previous modes, very energy efficient. So there should be some way to look at the total efficiencies of these transportation decisions, rather than just the modal opportunities.

**MR. SHIRLEY:** Any time you are looking at modal comparisons, you have to go to a case-by-case situation and examine where your ridership comes from, what mode you are going to take it from, and what mode you are going to give it to. You look at the whole picture so that you are not comparing a line haul situation with a portal-to-portal situation or something of that sort. You have to look at where the trip begins, and if it is a line haul facility, what kind of access and egress energies are required.

This may sound fairly simple to do, but people do funny things that you aren't prepared for. You have to look at what kind of service your facility is going to provide. To show you how wild some of this gets, many of the people who live in Walnut Creek, a suburb of San Francisco, commute to work using BART. One of the prime reasons for using a facility like BART is that you can sit back, read your newspaper on the way to work, and ride unflustered and relaxed. But if you board in Walnut Creek, you can't get a seat because the train originates in Concord. So people who live in Walnut Creek drive outbound to Concord so they can get a seat all the way to San Francisco. Now that is something the model doesn't put out for the planner to look at.

One important thing most assessment methodologies don't look at is placing a transportation situation in a regional energy context. I think you first have to decide how many kilowatts you are going to have available, what your peak hour demand for those kilowatts will be, and how much diesel and gasoline you are going to have, and then couch your analysis in those terms. If you are talking about adding cars to your electric rail line, know what that means at 5:00 when everybody has air conditioners on and you begin to get brown-outs and your transportation slows down to 5 miles an hour; that is an important shortfall in the CBO study. Also know how much land use change you are going to foster by your addition to the system, and the demand on regional energy supply caused by that.

**DR. HARTGEN:** The assessment methodologies for translating particular policy proposals into energy implications are, generally speaking, quite well advanced. But there are arguments about whether you use the right numbers. If we had the right numbers we could probably make pretty coherent assessments.

There are a number of methodologies available. The CBO technique has already been discussed. We have developed another in New York. We are not quite sure, however, about all of the numbers that go into these techniques. The assessment methodologies are very weak in predicting the change in travel behavior that results from a proposed policy.





A gaming approach we used in New York has helped us understand some of the very surprising ways consumers respond to energy constraints. We never would have predicted, with current procedures, the kinds of results that we saw consumers giving us. I had a chance to scan a report from San Diego, and I think there were some surprises in there about responses to energy shortfalls and prices and so on. That whole area of methodology needs some very strong and immediate attention, particularly as to how consumers will focus upon these questions over the next 10 or 15 years.

**MR. LASH:** So the analysis methodology is available, but some of the inputs which depend on information about human behavior just aren't available. We haven't studied those human behavior reactions enough to allow us to use the methods to the best advantage.

**MR. HULTGREN:** We have all been talking about only 20 percent of the travel, the home to work trip. Most analytical methods factor the other 80 percent off the work trips. Our analytical methods are not really good.

**DR. DIFIGLIO:** I think work trips are closer to 30 percent. One of the reasons we concentrate on them is because they have the lowest occupancy rate. Nonwork trips tend to have higher occupancy rates.

When we talk about intercity recreational travel, we don't have many alternatives to the private automobile, and the occupancy rate is around 2.5. It is hard to talk about expanding Amtrak when it is cutting back in order to survive economically. And aviation offers no energy benefit.

So I think we are somewhat justified in concentrating on the work trip. There the opportunities to eliminate congestion are the greatest, and auto occupancy is the lowest.

**DR. HARTGEN:** Let me respectfully disagree. When confronted with energy squeeze situations in '73, '74 and '79, the public cut discretionary travel, weekend travel, and recreational travel, precisely those components that we aren't focusing upon. We want to focus upon the kinds of actions the public will be taking. To me it makes no sense for government to propose impractical alternatives, and we know that habits in work travel are the most difficult to change.

**DR. DIFIGLIO:** The work trip is difficult to control because public policy has shaped it more than any other. Local, State, and Federal governments should provide alternative opportunities for work trip travel which don't now exist. The individual traveler can't by himself execute those opportunities without cooperation from government, which effectively has given him his menu of travel to work alternatives.

**DR. HARTGEN:** Once again I disagree. There are numerous options for work travel, like carpooling and transit, and one may choose where one lives and where one works. We have focused upon work travel because it is regular. We know what will happen every day of the week, and we know basically how to evaluate changes that we propose to it. In addition, until recently it has been radial and therefore easier to plan for with the methodologies developed in the 1960's.

Now we are in another ball game. If we continue to focus upon work travel, the public will again go off and do its thing. We will have a nice bunch of methods that will deal with 30 percent of the problem.

**MR. SHACKSON:** I agree. Part of the reason that we focus on work trips is the "look under the streetlight for the lost coin" syndrome. It is the one for which we have data. Our disaggregate data is woefully inadequate when we get out of the large urban areas for any kind of trip purpose.

The Michigan Driving Experience Survey is beginning to show inroads in nonwork trips. That particular survey was done at very modest cost in an innovative way. About 8,000 drivers were interviewed over a year period on a sampling basis at the time of the driver license renewal application. It was done by the managers of the driver license issuing bureaus and was designed to report the small community and rural trip making which has been missed in prior driving experience surveys.

I second what Dave Hartgen has said. We have options in the nonwork trip we haven't been able to address because we haven't really known what travel behavior has been.

**MR. LASH:** Earl, would you mention the method that you and your associates developed in California—the one outlined in the energy course you have been teaching during the last year or two under FHWA sponsorship?

**MR. SHIRLEY:** The methodology we published in NCHRP Report 20-7, "Energy and Transportation Systems," is easy to use. It discusses various levels of analysis and comes with a

bunch of energy factors. We didn't develop a lot of this ourselves; we just culled the available literature and made some hard decisions where we found more than one number. The factors include materials and construction energy as well as the direct energy of vehicles using the facility, so you can look at the energy costs to build one kind of bridge versus another, asphalt versus concrete pavement, or transit station energy.

If one wants to put enough effort into it, the method can be used to analyze an areawide system. You just have to know how many vehicles are going to be using a system, at what speed, and so on. This is where the method begins to fall apart, because as you project into the future you have a large amount of uncertainty.

**DR. HARTGEN:** Earl's report is a very, very useful document, and it should be promulgated widely. It's really the Bible of energy conversion factors in the transportation area. It is a very, very useful complement to other assignment-based and systems planning procedures, sketch planning procedures, and so on.

**DR. EPPS:** The data that is available for some of these models is very limited, and it has been developed very quickly. Most of the data has been developed by trade associations. The data developed by universities and other research agencies was done under very quick turnaround times. So I certainly question the data myself. We need more work in this area. I think they put us in the ballpark; we just don't know whether we are in left field or right.

**MR. JAMIESON:** It could be helpful if there was some way to compare different development options in relation to their energy savings. You could look at a new development and give it certain weights with respect to what it does, such as give a high weight to those providing for more walk trips, fewer vehicle trips, or multipurpose trips.

**DR. PESKIN:** There are a lot of analytical tools out there right now, land use models of various types, and a very comprehensive package of transportation planning tools. We showed at Northwestern that it was possible to tie these land use and transportation planning models together and simulate the interaction between transportation and land use in the context of urban growth, and to simulate a variety of transportation policies.

We used very simplified versions of these models. The results, therefore, are tentative but show that there is some promise in going ahead with these models, although not at a micro level of detail.

Further, it is possible to bring into this the optimization idea that Earl alluded to before. There are land use models which tend to optimize accessibility. One such model, TOPAZ, could include energy costs. That type of land use model, perhaps in the sketch planning environment, could be tied with other land use models to find urban forms which tend to optimize transportation energy. And I would like to believe that these models will allow us to explore, in more detail, the rational behavior of people who optimize the amount of travel and gasoline they have available.

**DR. DIFIGLIO:** Land use models have had particular difficulty in identifying statistically significant relationships between transportation investments and measures of activity. While transportation may be the biggest single factor affecting land use, it is overwhelmed by a multitude of other factors. In terms of answering basic questions, the models still don't come up with a "yes" or "no" answer.

The models are just not sensitive enough to determine whether the final result is a net plus or

a net minus; the models have not provided any sense of directionality. While they may offer insight into what happens in a local context, these models don't answer fundamental questions on a regional basis.

**MR. LASH:** Carmen, does that mean that you are really seriously handicapped in energy planning? If we haven't found those relationships thus far, they may elude us for many years. Should we be concerned about that, or are you telling us we better look at other kinds of tools to help us do the job?

**DR. DIFIGLIO:** I think we should look at other kinds of tools. And I am not advocating against utilizing land use analyses for comparing one project to another. For example, land use analysis was used to come to the conclusion that a longer Metro system would probably cause more suburban development than one that is shorter. That is a valid use of the models. Whether or not you have to use a statistical model to determine that or just common sense is kind of beside the point.



But it doesn't tell you whether or not the Metro system causes more or less dense development. While you may be able to use it to compare different alternatives, I caution against thinking that you have the answer to something because it came out of a model.

**DR. STOWERS:** I agree with everything Carmen said. That is where I started, working on land use models, and I have concluded that it isn't really worth playing with them if your only lever is transportation. There are so many other variables you are not dealing with. Land use models only become worthwhile when you are doing more comprehensive planning.

**DR. HARTGEN:** A model is a simplification and abstraction of reality. It is not reality itself. Reality is in the eyes of the modeler, and every model is in fact the statement of some person's perception of how the world is organized. The validity of that perception needs to be questioned, not the structure of the model.

Many models will replicate the present because there are many alternative explanations of the present. But I submit that only the best models will predict the future, and those are the ones which extract reality more objectively and realistically.

That is an area I think is ripe for research. We really don't know which views of reality are the most valid as energy constraints. Price increases squeeze travel in precisely the reverse direction from which almost all our models have been attuned, the expanding travel kind of problem.

**MR. SHACKSON:** Perhaps we shouldn't be concentrating quite so hard on energy models per se. I am wondering if perhaps we should be talking about transportation cost models in which the energy component is explicitly counted.

Let's go back to Bob's statement earlier, about the dilemma of the transportation planner trying to reconcile transportation objectives with a general regional economic growth objective. If he points to an economic statement and says that this will lead to a lower cost transportation system for the region, it has immediate implications for that region's competitiveness with other regions and can be translated into an economic growth objective. If he expresses it in terms of BTU's saved, it isn't quite as easy to do.

Certainly transportation in a period of rising energy prices can be a significant factor in the ability of a region to compete.



## Closing Statements

**MR. LASH:** I would like to use our remaining time to give each of you a chance to make a final point about any subject that we covered today.

**DR. HARTGEN:** Two very short points: First, the public is behaving rationally and will continue to do so. We need to incorporate those rational options into our planning. Second, if there is anything we don't know very well it is how travel behavior is likely to change in the constraint-oriented world. I submit that we need to get started very soon in understanding that.

**MR. JAMIESON:** I would encourage you in the Federal Government to get out more goals, objectives, and policies and far fewer predetermined solutions. Back in the War of 1812, we put a chain across the Potomac to keep the Red-coats out; that didn't work. We laid out a grid and radial street pattern that hasn't worked in any city. We have dug canals and filled them in again. We have developed traffic rotaries, mixing bowls, and busways. We have been overwhelmed with solutions that we can't use or afford. What the Federal Government is really good at is giving us policy direction.

The President just came back from Tokyo to say we won't exceed the petroleum consumption level of 1977. He set an upper limit, and now each of us should see how much energy we should save each year. If every State knew what its fair share was going to be, it could take this goal down to the regions or to the county level, and together they could develop a solution. For example, is that new development really going to make the area more energy efficient or is it just going to consume additional petroleum which means you have less petroleum for the trips already being made? I think we have got to get conservation decisionmaking down to the people who really have control over land use and transportation.

**MR. HEANUE:** I would like to reinforce what John said about targets. I think it parallels the work done on air quality. When the standards were available by urbanized area and everyone had a target to shoot at, it added a rationality to the whole analytical process that has been lacking in energy. And hopefully if this import restriction is parceled out, we will go through several cycles in the learning process and then the Congress will address energy again.

I have been very impressed with how fast the state-of-the-art in energy analysis is advancing. New things are coming out almost every day. But it would be a big shot in the arm to discipline it by quotas.

At an energy seminar last week, Roger Creighton showed how the pattern of travel by time of day has changed in Chicago. From a very sharp peak hour situation 15 years ago, we now find that the valleys have filled in and there is an enormous quantity of travel taking place in the evening. That is a relatively new phenomenon. Maybe by closing down suburban shopping centers two nights a week we could save more energy than all the things we have talked about here. It is an option that we haven't explored because we haven't had discipline in the process. Everyone is kind of groping in different areas.

**MR. SEAWELL:** Americans are colonial by attitude and our favorite area to colonize is the future. But with the vulnerability of the fuel situation, flexibility is going to have to be the nature of our plans. The consumer has fewer options than ought to be present in a free economy. He doesn't have enough opportunity to exercise in the marketplace what his true wants are, as I view it.

We have some neat parks in Denver where you can play Sterling Moss, driving around and around in a circle, wasting—but I think creatively wasting—gasoline. You can also ride the bus five days a week to work and get very frustrated with all the dingbats, saving a lot of fuel while getting from A to B. Options like this ought to emerge so people can do what they choose in a rational way and still achieve efficiency in the things they have to do.

**MR. SHACKSON:** We quite appropriately concentrated on passenger transportation today. But we need to be aware of the implications of what we do with passenger transportation on the demand for goods movements, and recognize that trucking is a significant consumer. I also have some concerns about the system safety implications of a continued thrust towards small cars and an equally logical move towards larger trucks. We didn't talk about that, but it is clearly related to energy concerns.

**DR. DIFIGLIO:** I would like to emphasize that planners should look at a wide range of alternatives and not be so quick to dismiss some ideas as being politically unacceptable. They need to find innovative ways to test out these ideas, find ways to extend the problem beyond the question of getting it before the MPO board.

The political acceptance of transportation innovation is something they have to think about ahead of time, to avoid coming up with a program and just thrusting it on the public without any kind of preparation, without any kind of public relations. While it's true you can't create demand for something that people aren't going to accept, you can certainly screw up the reaction to a good idea by doing it inappropriately. The planner has to see the problem through to public acceptance of the idea, and selling it is the hardest job of all.

**MR. SHIRLEY:** I have two points. One is to emphasize that any energy analysis should be done on a life cycle basis.

**MR. LASH:** You mean, not simply considering construction but going on and putting in maintenance and vehicle propulsion energy and operating energy.

**MR. SHIRLEY:** Yes, going on to replacement and salvage value. I think your results are going to be very biased if you don't do that kind of thing.

Another part of the picture is that if we don't conserve petroleum now, we may find a fairly precipitous rush into coal technology. That could mean we would have an awful lot of environmental degradation occurring just to get things going. We have enough problems with acid rain-fall in the Adirondacks now, and we had better start thinking about this.

**MR. LASH:** We really covered a lot of ground today. Although the panel did not agree unanimously on many of the issues, the important thing is that the panel reflected the present state of understanding and knowledgeable opinion on the energy problem. Answers are not clear and simple, and there are many viewpoints on the same questions even by knowledgeable students of the problem, as you are. Nevertheless, readers of the panel proceedings will benefit from the discussion of various sides of these issues. Hopefully, they will gain a better perspective on the problem and on their individual roles in helping to conserve energy.

I think this was a wonderful panel. You worked very hard, and we appreciate it. Thank you very much.