DOT-TST-76-77

Intermodal Safety Research Needs

Report of the Sixth Workshop on National Transportation Problems April 28-29, 1976 Program of University Research

U.S. DEPARTMENT OF TRANSPORTATION

OFFICE OF THE SECRETARY
Office of Safety Affairs
and
Office of University Research
Washington, D.C. 20590

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15. Supplementary Notes

16. Abstract This conference brought together DOT policymakers, university principal investigators and other professionals to consider the intermodal safety research requirements of the Department of Transportation. The objectives of the conference were:

- To highlight safety problems and needed transportation safety research identified by DOT modal safety managers and to stimulate university or university/industry teams to respond with research proposals which emphasize multi-modal applicability and a systems view.
- To provide a forum for university research groups to inform DOT safety managers of promising new directions in transportation safety research and new tools with which to address safety related problems.

The conference addressed the research requirements for safety as identified by the Statement of National Transportation Policy and by the modal safety managers in three principal contexts, each a workshop panel:

I - Inter-Institutional Problems of Transportation Safety. Problems were described as: Federal-State, local; Federal-Industry; Federal-Public, Consumer groups.

II - Goal Setting and Planning for Transportation Safety Programs. Issues were: modifying risk behavior, safety as a social value, and involving citizens in development of standards as a way of increasing probability of achieving program objectives.

III - DOT Information, Management, and Evaluation Systems Requirements. Needs were: data requirements and analytic tools for management of safety programs.

17. Key Words	18. Distribution Statement
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U. S. DEPARTMENT OF TRANSPORTATION
OFFICE OF THE SECRETARY

INTERMODAL SAFETY RESEARCH CONFERENCE

Sponsored Jointly By
Office of University Research and Office of Safety Affairs

EXECUTIVE SUMMARY

As one of a continuing series of workshops to develop information useful to DOT policymakers, the sponsoring offices convened a workshop on Intermodal Safety Research Needs on April 28 and 29, 1976.

Attendees included policy and R&D representatives from each DOT administration, industry spokesmen from each mode, and university representatives engaged in transportation safety research.

CONFERENCE OBJECTIVES

- To highlight transportation safety problems and needed research as identified by DOT modal safety managers, and to stimulate universities to respond with research proposals which emphasize multi-modal applicability and a systems approach.

- To provide a forum for university researchers to inform DOT safety managers of promising new directions in transportation safety research and new tools with which to address problem areas.

The Conference addressed the research requirements for safety as identified by the Secretary of Transportation's Statement of National Transportation Policy of September 17, 1975, and by the modal safety managers in three general contexts, each of which was the subject of a workshop panel.

PANEL I -Inter-institutional Problems of Transportation Safety. To Identify Problems in Federal-State-Local Relations, Federal-Industry Relations, and Federal-Public Relations.

PANEL II -Goal Setting and Planning for Transportation Safety Programs. To Relate Citizens' Willingness to Risk and Their Involvement in the Development of Standards with the Probability of Attaining Safety Objectives.

PANEL III-DOT Information, Management, and Evaluation Systems Requirements for Management of Safety Programs. To Develop Requirements for Data, Analytic Tools, and Information Systems to Enhance the DOT Decisionmaking Process.

SPECIFIC FINDINGS

The principal value of this conference was in the exchange of views between safety program managers and industry representatives who expressed safety needs and university investigators who described research capabilities. Conference conclusions will be translated into requests for research proposals and the revision to the draft FY 1977 Annual Solicitation for Research and Seminars under the Program of University Research. University research proposals submitted after careful reading of this report should be more in conformity to DOT safety needs.

The major areas of consensus were:

- Research in specific modal safety problems would be useful not only in developing specific solutions, but also in building a base for national level extrapolation and in increasing the number of experienced safety practitioners.

- New methodologies which supplement present technology transfer techniques must be developed for removing barriers in promoting safety.

- One reason for institutional barriers is that the available data, though technically correct, is not adequate to convince many industry and local users.

- Interests of the public must be recognized (even in technical areas such as hazardous materials categorization) and programs must be developed which provide enough information to enable the public to make informed judgments on the basis of various value systems.

- Value systems of population segments must be investigated before analysis can be made of social and economic consequences of alternate safety programs.

- The state-of-the-art in value system analysis and attitudinal research does not permit reasonable assurance of substantive input for mid-range safety programs. Long range basic research must be undertaken in these areas to improve predictive ability.

- Consumer participation is needed to establish safety goals, objectives and standards if compliance with such standards is to be improved.

- The current data base for safety-related program decisions is not adequate, nor is the agreement on the type and range of data elements required for safety program decisions.

- Safety research would be facilitated if all existing data collections were drawn together and made available with indications of their scope and data quality.

- The use of different measures as well as different definitions of the same measure (e.g., What is a fatality?) makes intermodal comparisons of safety rates ambiguous or impossible.

The following relate to problems encountered in transportation safety research by universities:

- Safety has no disciplinary focus within the university. Fragmentation among discipline prevents coherent program development at the university department level. This is particularly acute when integration of engineering and behavioral sciences are needed.

- There are communication weaknesses between DOT and the universities. Increased effort is required to translate the safety problems as perceived by safety managers into research requirements as understood by the university investigators. Research results often are because they are presented in theoretical terms and general formulae.

- Universities have contracting problems with DOT. Research in the problem areas identified by DOT safety managers requires long-range professional commitment and multi-year efforts. Single year funding and the inability to make long term commitments to support basic research discourages university attention to such problems. Additionally, the cost or proposal submission and the low probability of acceptance are deterents to a vigorous DOT safety research program.

FOREWORD

Remarks of the principal speakers have been extended in the text of the report. Mr. Marion F. Roscoe, Associate Administrator for Safety Affairs, Federal Aviation Administration was unable to attend the conference as planned. His prepared remarks have been entered in the conference record. The remainder of the conference transcript has been edited. However, no substantive issue has been deleted.

PREVIOUS CONFERENCE IN THIS SERIES

No.		
1	Transportation and the Rural Community	May 30-31, 1974
2	Urban Transportation Policy	Nov. 7-8, 1974
3	Regulations and Transportation	Feb. 11-12, 1975
4	The Role of Government in Transportation R&D	June 5-6, 1975
5	Regulatory Reform and the Federal Aviation Act of 1975	Feb. 29-Mar. 1, 1976

A key work in context (KWIC) index of this report is availabe upon request.

NOTE: The above reports are available through the Office of University Research, and may be obtained until their supply is exhausted.

Please address inquiries to:

Office of University Research (TST-60)
Office of the Secretary
U. S. Department of Transportation
Washington, D. C. 20590

INTERMODAL SAFETY RESEARCH NEEDS

AGENDA

WEDNESDAY APRIL 28, 1976

8:00am WELCOMING ADDRESS--
Honorable John W. Snow, Deputy Under Secretary of Transportation

9:15am KEYNOTE ADDRESS--"Is Safety Research in Balance with Safety Programs?"

Honorable Judith Connor, Assistant Secretary for Environment, Safety, and Consumer Affairs

9:45am "Fighting the Alligators" A Discussion of Safety Research Needs by Modal Spokesmen:

Philip Bolger, Director, Office of Safety Affairs, Chairman

RADM William M. Benkert, Office of Merchant Marine Safety, USCG

Cesar Deleon, Director, Office of Pipeline Safety, Materials Transportation Bureau

Vincent J. Esposito, Director, Office of Vehicle Safety Research, NHTSA

Robert E. Parsons, Associate Administrator for R&D, FRA

G. J. Pastor, Associate Administrator for R&D, UMTA

James L. Foley, Jr. Director, Office of Highway Safety, FHWA

Marion F. Roscoe, Assistant Administrator for Aviation Safety, FAA

11:30am "Draining the Swamp" A Discussion of Safety Research Trends and Technology by University Research Speakers

Dr. Michael J. Rabins, Director, Office of University Research, Chairman

"Control of Harm: Research Needs for Understanding the Control of Hazards and Formulating Wanted Solutions for the Problems."

Dr. John V. Grimaldi, Director of the Center for Safety, New York University

"The Dangers of the American Road: Traffic, Terrain, Weather and other Factors Affecting Transportation Safety Needs and Possible University Research Work Addressing Them."

Dr. B. J. Campbell, Director, Highway Safety Research Center, University of North Carolina

"Transportation Safety from a System Viewpoint: How Transportation Safety was studied up Until Now. Need for a Systematic Approach. What is System Safety Methodology? A Look Towards the Future."

Dr. Louis J. Pignataro, Head, Department of Transportation, Polytechnic Institute of New York

"What to do with the Alligators?"

Dr. Herold A. Sherman, Executive Director,
Institute of Safety and Systems Management
University of Southern California

12:30pm LUNCHEON -- Available in Hotel: no group arrangements

Demonstration of TRISNET

1:30pm "From Modal Problems to Departmental Decisions"

Philip Bolger, Director, Office of Safety Affairs

2:00pm PANEL I: "Institutional Problems in Transportation Safety"

Moderator: Donald W. Bennett, Federal Railroad Administration

5:30pm RECESS

6:00pm RECEPTION -- No Host: Room to be announced

7:00pm DINNER - Room to be announced

Dinner Address: Honorable Webster B. Todd, Jr.
Chairman, National Transportation Safety Board

THURSDAY, APRIL 29, 1976

9:00am PANEL II: "Planning and Goal Setting for Transportation Safety Programs, The Consequences of Process"

Moderator: Mr. C. F. Scheffey, Director of Research, Federal Highway Administration

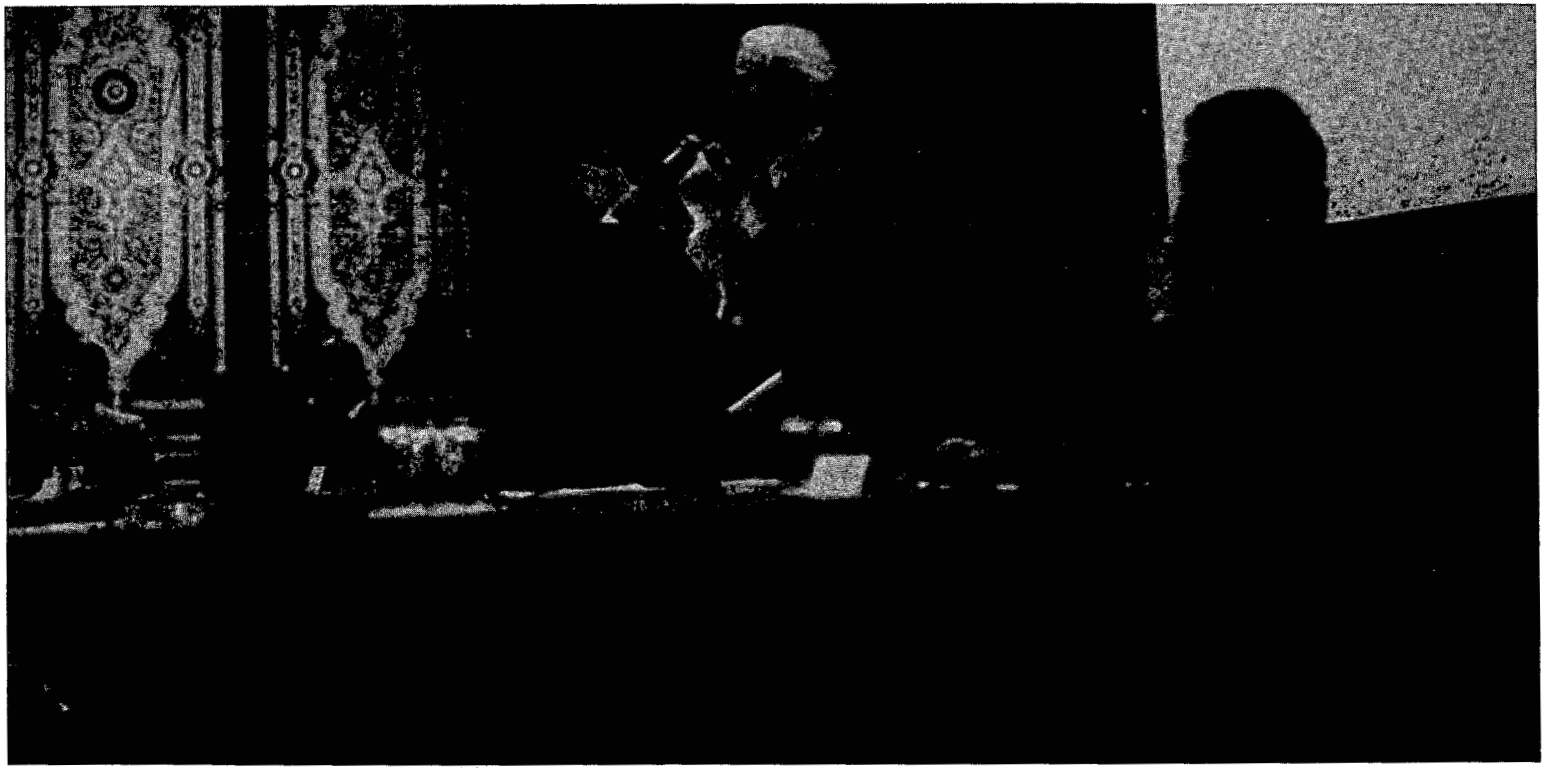
11:30am LUNCHEON -- Room to be announced

1:00pm PANEL III: "Departmental Management, Information and Evaluation Programs; Decision Making in a Worls of Change"

Moderator: Dr. James Costantino, Director Transportation Systems Center

3:30pm PLENARY SESSION: Concluding Remarks

4:30pm Adjourn



CO-CHAIRMAN MR. PHILIP BOLGER, DIRECTOR, OFFICE OF SAFETY AFFAIRS AND
DR. MICHAEL J. RABINS, DIRECTOR, OFFICE OF UNIVERSITY RESEARCH

PREFATORY REMARKS
Mr. Philip H. Bolger
Director, Office of Safety Affairs

Let us start the proceedings. I would like to welcome you to the sixth of a series of conferences on transportation research. This conference is sponsored jointly by the Office of Safety Affairs and the Office of University Research in the Office of the Secretary of Transportation. On behalf of Dr. Michael Rabins, Director, Office of University Research, and myself I would like to welcome you to the conference and to thank you for taking your time to meet with us for these two days and discuss these urgent matters.

In the past these conferences have focused on such problems as the government role in regulation, rule-setting, and transportation research and development. This conference is dedicated specifically to the inter-modal and multi-modal safety research requirements of the Department of Transportation.

In prior year university grants programs, the solicitations and the responses that we have received from the universities have not been entirely what we have been looking for. The problem as we see it is twofold. First, we in the Department may not have been clear in explaining our requirements and our needs for safety research. On the other side of the coin, we have not asked the universities to come in and discuss their capabilities and their thoughts concerning what they can do to work with us. That is the purpose of this conference.

The group today represents both individuals from universities working in transportation that can make contributions to our needs in safety R&D and also individuals from the Department representing the various modes who will discuss their safety problems and their R&D needs to meet those problems.

As you know from your program, we are going to have a series of panels. However, to set the stage we will first have a discussion by modal representatives who will discuss the R&D needs as they see them to meet their safety problems.

Next will be a discussion by university representatives of what their capabilities are that they feel will meet some of our problems. Finally we will have three work sessions or working panels to discuss institutional problems of transportation safety, planning and goal-setting involving the use of available resources for meeting safety problems, and third, and a most important one, is how do we get proper information and data to do our planning within the Department?

To welcome us to this conference is the Honorable John Snow, Deputy Under Secretary of the Department of Transportation. He was appointed to that position May the first of last year. Prior to that he acted as the Assistant Secretary for Congressional and Intergovernmental Affairs of the Department. He is a graduate of the University of Toledo. He attended Johns Hopkins and the University of Virginia and was awarded a doctorate in economics in '65. After that he attended George Washington Law School, receiving his law degree in '67. It is my pleasure to introduce Mr. John Snow.

WELCOMING ADDRESS
Honorable John W. Snow
Deputy Under Secretary of Transportation

Thank you, Mr. Bolger. You can tell by the introduction from Phil that I am truly educated beyond my depth. The only reluctance I had to accept this invitation to welcome you today is that the last time I accepted an invitation to welcome people to a group like this was at the invitation of Mike Rabins who was hosting, along with Phil Bolger and Judith Connor, a conference. They invited me to be on the panel with a distinguished group of advocates for a position contrary to the position the Department was taking on a number of issues. One of these gentlemen was a member of the Interstate Commerce Commission. He was a tall, handsome fellow, and a gifted speaker. He spoke with tremendous erudition and a magnificent gift for the English language. In the course of that address he moved the audience from the heights of dizzy passionate frenzy to the depths of despair and he touched every emotion in between, a magnificent performance. I gave my usually prosaic talk. At the end, swarms of people came before the Commissioner and one sole approached me, a lady about 65, and she put out her hand and she said, "Mr. Snow, your speech was utterly superfluous."

I thought, well, my friend the Commissioner, or Mike, has put her up to this and I will play along, so I said, "Well, thank you, Ma'am, that is one of the kindest things anybody has ever told me, and on the basis of that representation I think I will have the speech published posthumously," and she said, "Well, in that event, the sooner the better."

It is the function of a welcoming speaker to be brief and to set the proper tone for the deliberations to follow. Of the two, far and away the most important is the former, so I will fulfill the highest ideals of a welcoming speaker and be brief.

We have in the United States a magnificent transportation system, no doubt about it. It is a good system and it works. The best airlines, railroad, highway, and waterway systems in the world. But while we praise the American transport system, we also recognize that it is not performing in many respects as well as it should. It can and should be better. Many railroads are in bankruptcy. There is a state of physical deterioration in parts of the railroad system. We are concerned that this deterioration may well spread. We are concerned about the long term funding for the highway system. We are concerned about the state of the highway system in 1990 and the year 2000. We are concerned about congestion and pollution. We are concerned about a number of problems, and believe that the U.S. transportation system can be made to work better.

One major problem, of course, is that we have overregulated it. We have applied a regulatory system to our transportation industry (water, rail, air and truck) not appropriate to the underlying economic realities. We have started to make a good attack on that problem. The administration, as you are probably aware, through the Department, has sent to the Congress three major pieces of legislation, rail, air, and motor carrier regulatory reform bills, to bring the regulatory climate into harmony with the underlying economic realities.

In making the case for regulatory reform of our transportation system we have drawn very heavily upon the work done in academic circles. As a matter of fact, I don't know of any area of public policy in which the academic community has played a

larger or more significant role in influencing public policy. Our rail bill, our air bill, and our truck bill are all based upon significant research done in the universities, research which tells us that the present system is not working well and why it is not working well. Not only did we draw upon research done in the academies, research institutes and universities pointing out the deficiencies in the present regulatory system, but also in fashioning the cure, in fashioning the legislation. So, the people doing the research worked with us in fashioning the legislative answer to the problem. We are very pleased with that tradition.

I would like to see that tradition extended. One important area where this can happen is in the field of safety. Certainly safety is one respect in which the American economic system stands in need of improvement. We can and will improve the safety characteristics of the U.S. transportation system. If we are going to do so appropriately and properly, we need help and we need the kind of help from you which will enable us to better understand the problems and to better design the cures for the problems. So, as I understand the purpose of this conference, it is a noble one. It is for us to set out to you what we view as the problems, what we view as the goals of the administration, and the Department.

For you in turn, it is a chance to tell us what your thinking is, to tell us what the state of research in the academies and the universities is and how it can apply to the problems we have. This research must be inter-modal. It must deal across the modes. It must be inter-disciplinary. I don't think any one discipline is deep or broad enough to solve these problems. There will be an enhanced productivity in addressing the problems by dealing with them on an inter-disciplinary basis.

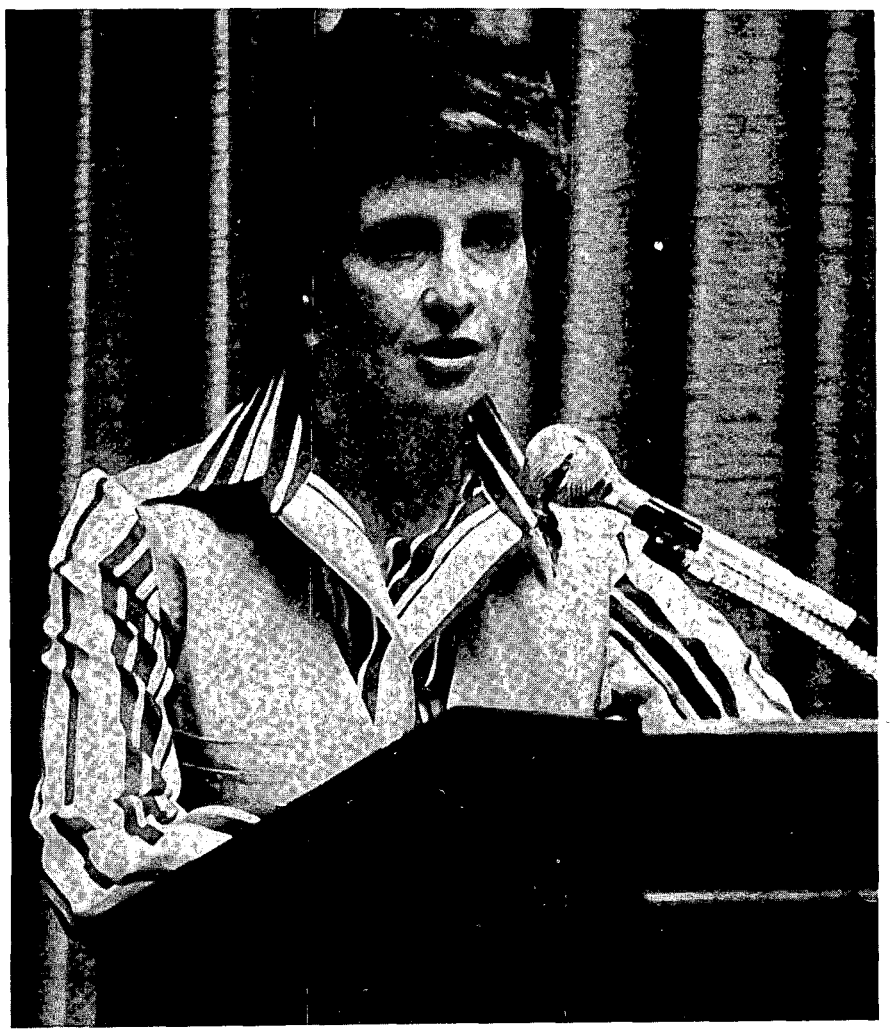
In part, the problem is technological. In part, it is going to involve better data, identifying cause and effect relationships, and it is also going to involve a better understanding of institutional relationships. Why does the market process under-produce safety? Under what conditions does it over-produce safety? If it under-produces safety, does it under-produce safety because of monopoly conditions associated with the production of safety or the components which go on to the vehicle or the components which go on to the transportation device? If there is a safety problem, is it one best addressed by a rule or regulation or is it best addressed through dissemination of information? What about insurance? Insurance is an alternative way of dealing with safety problems, reflecting safety risks and creating incentives for people to behave in risk avoiding ways.

I don't have the answers. I hope the steps in the direction of getting the answers will emerge from this conference. With the talent assembled here I am confident that is the case and I look forward very much to seeing the results of your deliberations.

Thank you.

MR. BOLGER: Thank you, John.

Our keynote speaker is the Honorable Ms. Judith Connor. She is a native of Toronto, Canada, a graduate of Wellesley College, and a holder of a Masters degree in business administration from Columbia University. She is now the Assistant Secretary for Environment, Safety, and Consumer Affairs. Her title alone, in itself, is enough to establish our conference charter. We are all consumers of transportation; we want to do it safely, at a reasonable cost to the consumer, and without polluting the environment. Her organization is responsible for many of the intersecting problems required to keep these programs balanced. Her remarks, however, will deal with another kind of balance. "Is safety research in balance with safety problems?" So with that I give you Canada's gift to the United States, Judith Connor.



THE HONORABLE JUDITH CONNOR
ASSISTANT SECRETARY FOR ENVIRONMENT, SAFETY AND COMSUMER AFFAIRS

"IS SAFETY RESEARCH IN BALANCE WITH SAFETY PROGRAMS?"
Honorable Judith Connor
Assistant Secretary for Environment, Safety and Consumer Affairs

Mike picked me up this morning and looked at the beginning of my speech and it said here, "Good morning, ladies and gentlemen." Mike crossed the "ladies" out and I am in a little bit of a dilemma now. The feminist movement always suggests that if there is one lady in the audience, you shouldn't say "Good morning lady and gentlemen," and point her out, but one lady walked in, so now I really don't know what to do. I guess I will just say good morning to everybody and welcome to this conference.

I would like to share with you this morning some of the concerns that we confront in the Department of Transportation when we are making decisions about the safety programs and about safety research funding. Just like paying taxes, our funding decisions come around at least once a year, but the basis for decisions regarding those studies that we will fund is not as precise as the instructions on the IRS forms.

Depending on your memories of April 15th, perhaps I should say that the means for arriving at the bottom-line conclusions is equally obscure as the IRS form. I would like to talk a few minutes about the reasons for our dilemma in a very general way and some of the ways in which you might contribute to the search for good solutions and for good decisions.

If we look for guidance in the legislative history of safety programs, it is obvious that there is a clear mandate from the Congress to the Department of Transportation to do something about the problems of safety in the field of transportation. There are few, if any, in the country who would not like to reduce the likelihood of air crashes, the fatalities and injuries on our highways, or the toll of accidents in other segments of the national transportation system. However, as the legislative directives are translated into program guidance, questions start to arise: "do what?" and "when?" and "how?" are questions that generate considerable controversy within the Department and outside of it and they raise vital issues of "equity", "effectiveness" and "desirability."

When faced with a clear cut and socially desirable goal such as the reduction of transportation fatalities, a range of program options are easy to come by and I am sure that each member of this conference has spoken out in favor of at least one specific program plan. Most of the programs proposed will be effective and are desirable, but we do have to ask ourselves whether they contribute to a coherent, suitable safety program which is consistent not only with our national transportation policy, but also is within reasonable budgetary guidelines. Do the programs have conflicting goals, attempt to channel the same activities into a different course of action, require excessive resources, use the same resources in different ways, or would they lead to a fragmentation of effort, a confusion of goals, a waste of limited resources which would leave us no better off than we are now?

One of the major roles of the executive in the Department of Transportation is to seek a balance among the objectives and among the programs and the activities. But as we look at this balancing act, we don't see the calm deliberate steps of the tightrope walker; instead, we see jugglers with many balls flying

through the air. The Department must seek not one but many balances.

First, there is a balance between the efficiency of the transportation system and safety itself. It has frequently been pointed out that 100 percent safety can only be achieved in a system which has been shut down. This is not a balance. We must weigh safety on a relative scale -- what price in terms of performance are we willing to pay for varying degrees of safety assurance? An example I can use of this is the recent issue we have confronted with the LaGuardia bombing. This is the classic case of trying to determine where the balance is between the kinds of safety and security measures that we could implement in our airports and those kinds that are acceptable in terms of the American's desire to move quickly when they move through the airports.

The second balance is between safety and other socially necessary or desirable goals. Energy conservation, noise abatement, and pollution are three such goals which have only recently been added to this list of trade-offs.

The third balance is among the many competing firms that make up the transportation industries. We cannot forget that safety programs have a definite impact on the economic viability of firms and of industries. Safety programs affect entire modes and firms within these modes as well as firms involving major manufacturing and construction components. Changes can have serious consequences for the private sector and they must not be too frequent; they must be demonstrably desirable and they must be even-handed. Above all, they must not appear to be whimsical or arbitrary to the affected industries.

The fourth balance is among the safety programs. Do we attack the most serious problem with all of our resources or do we apply a more limited effort to each problem, apportioning resources among the various problems proportional to their effects, or is some other allocation model more desirable?

The list of balancing acts can go on forever. Consider the widespread diversity of interests in transportation, the using public, the transportation industries, public interests, governmental units, and the economic weight of the infrastructure. These are all things that we must consider as we make decisions regarding our resources.

Balance is a crucial concern, then, for the federal executive and it is easy to see that we won't tip the scale 100 percent in any direction, but how do we achieve an optimal balance? That is the question that we have to ask ourselves and it is a question to which I think you can contribute an answer. In order to answer the question from your standpoint, it is necessary to have a little bit of insight into the pressures around an administrator's office, and I can assure you from my experience in the Urban Mass Transportation Administration that these pressures are truly phenomenal because every major issue comes to an administrator's desk and he has no capability to control those issues in terms of their timing or their volume. Each issue is usually carried by extremely effective advocates, either from his own staff or from among the interest groups that I mentioned earlier. It is within the context of these daily program decisions that an administrator must make decisions regarding the definition and implementation of his on-going safety program and his annual research efforts.

In order to understand its own environment, the research community must be aware that program administrators simply do not have the luxury of avoiding decisions. Each problem must be faced and some action taken. In fact, no action may be a decision to reduce the resource allocation to zero and expend funds on a different program. This may be the right answer and the right balance at the time and it may be the wrong one.

We do not have an accurate or fairly detailed map of the future, so the administrator must make these decisions under uncertainty. One of the most valuable services that the university research program can provide is assistance in providing guideposts for actions. How can we predict the consequences of various safety programs? What information is required to best make these decisions? How can we develop and administer a safety program so that it becomes a self-fulfilling prophecy, that is, that the program administration itself creates the conditions and the public support which will lead to program fulfillment? These are broad questions but they fall directly within the scope of the University Research Program for transportation policy research.

I think an example of what I am talking about is the recent highway needs study by the National Highway Transportation Safety Administration and the policy office of the Secretary. This was an extremely interesting and technical effort to try to set the priorities in the highway safety need area. We all agree that it is not necessarily the most refined or the most sophisticated approach to the problem, but it is one of the most systemmatic efforts that we have seen since the beginning of the program to try to assess the benefits and the cost associated with a whole range of alternate approaches. I highly recommend that study to you to take a look at in terms of its guidance for management decisions.

When I first came to Washington, I started to deal with the Congressional representatives. I was amazed at how little time they take to review an issue and how little they apparently knew before deciding on their votes. I subsequently learned that the only way to be effective in the Congressional environment is to telegraph messages to them. That is, to give them the most pertinent facts just as fast as you possibly can. By absorbing such facts from a variety of sources, the best representatives get a fix on the proper balance. The worst do not and they do not last long.

The executive officer is not much different. He also must rely on quick, concise information in order to evaluate where his vote goes. I urge you to think in these terms as you define your research efforts and your research products. The point I am trying to make is that we all need information fast in order to make the kinds of highly complex decisions that we are faced with. We simply must have an influx of accurate information in a form in which we can absorb it very, very quickly. I think this is important for everybody who is trying to affect decision-making at the federal level.

I would like to return to the theme of balance for just a minute and ask a couple of questions. First, "Have we in the Department selected the right problems to attack?" Second, "Do we have adequate information about the problem to attempt a solution?" Third, "Do we have a balance in research to support our on-going safety program?" With respect to the right problems, we face a wide range of options. Some are better than

others. Some can be accomplished more quickly than others, and some can be accomplished with less objection than others.

The Department does try to achieve a balance between seeking the long range "best" and the short range "good." For example, the long run problem of railroad safety depends on the economic viability of all of the rail network so that the railroads themselves can conduct the needed equipment research and testing, the track maintenance, and the personnel training required to achieve safe conditions. But in the interim, the Department recognizes its responsibility to maintain certain standards of safety which must be upheld even though it may divert resources from the long run effort. The challenge is to identify the problems in each mode which must be faced now versus those which can be left to the gradual approach achieved from longer range solutions.

What test can we apply to a problem to firmly place it in one category or another? We have a few specific problems in this area.

One problem is modal orientation. The vast majority of fatalities occur in the highway mode. The highest rate of fatalities per passenger mile is in general aviation. Should the Department allocate funds to equalize the risk rate or to minimize the total casualties?

How do we handle the dramatic event? It is clear that we need to prevent catastrophic accidents, but in a practical way how do we allocate resources between preventing the high cost but low probability accident and the low individual cost but high frequency accident?

Finally, how do we select among competing research interests, that is, those with technological or hardware orientation and those with a methodological process or systems orientation? Top management is often biased towards the latter with the staff specialist bias leaning much towards the former, that is, the technological research. The options present very, very different choices for the federal manager.

The second issue I raised is related to the adequacy of information and this was in any specific problem area. Obviously the availability of a data base interrelates with the selection process and directly influences the quality of this process.

It is much easier to get agreement on courses of action if we can get agreement on the validity of the underlying facts, but the cost of collecting and maintaining a large data base is obviously high. The Department therefore desires to minimize these costs to industry and to the government by collecting only the essentially needed data, but what data do we collect? How detailed should it be? How should it be collected and who will pay for the collection? We have noted an increased interest in data about the cause of accidents instead of the traditional statistics of the number of accidents that are occurring within the Departmental modal structure.

The NHTSA program, for example, plans to collect a nationwide statistical sample of automobile accidents and will begin to collect causal data on a large enough sample of accidents to provide a major improvement in the information base of highway accidents and fatalities. In this connection, I would like to bring to your attention the demonstration which is being set up for your convenience today. The Office of Systems

Development has set up and will demonstrate the capabilities of TRISNET which is the national network of transportation research information services. The network covers a wide range of information which is available to all of those doing research in the transportation field. We are also making available a copy of the Transportation Safety Information Report, a quarterly publication of the Office of Safety Affairs which uses the TRANSIS data base. This data base represents a synthesis of all of the safety-related data banks we maintain in the Department and helps us to identify and analyze accident rates, major safety problem areas, and significant events or trends in safety statistics.

The third issue I raised was related to the research support needed for any on-going program. There is an unquestionable need for research in refining the methodology used by decision-makers in evaluating the direct and indirect consequences of their existing programs. In the past, safety programs and safety regulations may have been implemented without adequately measuring the non-safety consequences of our actions. Times have changed, so that it is only recently that the economic, social, environmental, and energy impacts of a safety program have been incorporated into the process of review. For this reason I do heartily welcome the regulatory reform initiatives introduced in the past year or so by the President of the United States, which also was discussed somewhat by John Snow earlier. These initiatives essentially force all decision-makers to consider a host of consequences inherent in both proposed and existing policy or regulations.

However, in implementing these initiatives, I have discovered that although our intentions may be honorable, we again often lack the methodologies to use in assessing these unquantifiable and indirect impacts.

Cost benefit analysis, while useful, can be awkward and unreliable when applied to certain factors. Some factors simply can't be translated into monetary terms. What is the cost of dividing a neighborhood with a freeway or the cost in personal liberties of mandating seat belts and motorcycle helmets? As we all know, a cost benefit analysis can be manipulated to produce the required conclusions simply by plugging in arbitrary costs of the unquantifiable impacts. We must search for methods to reshape the analytical process to permit a thorough and rational analysis of human and environmental impacts without forcing them into monetary pigeon holes. The room for your creativity and imagination in this endeavor is vast.

In summary, I urge you to think in terms of assisting us in performing the balancing act. You can do this by learning as much as possible about the entire range of problems we face, by being sensitive to the complexities of the public policy environment, by assisting us in identifying priorities, and by helping to identify needed data, to collect and to analyze it.

Last, but not least, your contributions must be delivered in a form which is comprehensible and concise enough to be used either by the decision-maker or to influence the decision-maker. This obviously is a tall order.

The evolution of R&D products which are effective depends a great deal on the adequacy of R&D proposals that we receive and then the excellence of the work to be accomplished. I have raised the issues which we must consider as we try to develop general policy guidance. I trust that as you work with the panels during this conference and as you address very

specific problem areas in the coming months, you will contribute to our efforts to move from the statement of needs to a statement of achievement.

That ends my prepared remarks. If I were like Secretary Coleman right now, I would say, "That ends my prepared remarks, most of which were prepared by somebody else, and now I will tell it like it is." But I would like to make a couple of comments.

For one, I tried to weave through my speech references about the cost cutting trade-offs that we face and then when I re-read it this morning I realized that there wasn't a lot of multi-modal or inter-modal emphasis in the speech and that is the title of your conference. I happen to think that this is important enough to stress. In the Office of the Secretary one area is of primary interest -- to make sure that those techniques and those skills that are developed in one mode, which are applicable to the problems that are being faced by another mode, will in fact be transferred. Again, my experience in a modal administration demonstrates to me that you are simply too busy in your day to day problems to be able to go over to your sister agency and ask them what they have done in this particular field. Usually what they have done may be related but not related enough for you to be able to sit down and reshape it, so I feel it is our responsibility to urge the research community to ferret out those areas of commonality and to apply what is known in one agency to the problems that are coming up in another agency.

I had a good example of this yesterday. I was being briefed by the Federal Highway Administration on the work that they are doing in citizen participation and in the environmental impact area, and I discovered that they have had many courses, many of which are very interesting and very applicable to other agencies, that they are further ahead because they have been out in front in terms of trying to do impact statements and trying to involve the citizens in their decision making.

One course that they are currently developing and sponsoring is on how to prepare an environmental impact statement. It seems incredible that after all of these years that that is just beginning, but I must say that FHWA has developed a sophisticated approach to preparing their impact statements which is well beyond the approach that the other agencies have adopted. Not only is it beyond it, but it gets more to the heart of what the EPA Act actually requires that one address.

I raised the issue with the highway people as to whether or not they had invited the other modes. I am particularly concerned about UMTA and FRA who now face, for the first time, the necessity to go through what has been a very agonizing experience for FHWA, and they said no, they hadn't really thought about it. So here was a full-blown program on the importance of the items to be addressed in an impact statement by an agency that essentially knows how to do it and it was not being shared at all with the other agencies.

Now I recognize that because of their funding FHWA has limited space and obviously they want to train their own people. Nevertheless, I would like to see UMTA involved, where I think there are now two people working in that field, so it wouldn't be too difficult to train those two. FRA hasn't even gotten started. Frankly, they have just recently taken a woman from my staff in order to form their environmental staff. I am pleased with that, because I think it helps to take people that have experience in the Office of the Secretary transferred to the

operating administrations.

I make that comment just to stress to you that very often it is the research community that knows what is going on across modes and we ourselves don't always know about it. Please be sensitive to that, be sensitive to looking at what has been done and use these skills to address new problems. If you are starting to address a problem in one mode and you are going to do some research on it, look in other modes. Certainly look in the other modes to see what kinds of techniques have been successfully applied.

The next comment I wanted to make was that I did exclude from my speech a reference to alligators and swamps, which I understand is the theme for the day. I asked Mr. Bolger what that analogy was all about and whether or not it was military background. I find that among those liabilitites that we women tend to carry along with us is an inability to comprehend the lingo that comes out of the armed services and he assured me that he wasn't keeping any secrets from me and in fact seemed to feel that it was a quite obvious analogy.

I think the reason I have problems with what he described to me as one of fighting alligators as being typical of fighting day-to-day problems and never being able to drain the swamp, which is what may be the longrun objective, is that I also wear the environmental hat and that analogy applies beautifully to safety but it doesn't apply at all to the environment where we are trying desperately hard to keep FHWA from in fact draining the swamps.

So that, I think, is the reason for my mental block against that analogy, but I do hope when you apply it to your safety research interests that you do focus on the day-to-day issues and appreciate how difficult it is for us to get beyond those day-to-day issues and into the larger areas where we don't have the time to think about where we are going in the long run and precisely how we are going to get there and apply the kinds of skill which you have which we can't pretend to duplicate to help us get to our common objectives.

Thank you very much.

"FIGHTING THE ALLIGATORS"
A DISCUSSION OF SAFETY RESEARCH NEEDS BY MODAL SPOKESMEN

Philip Bolger, Director, Office of Safety Affairs, Chairman
RADM William M. Benkert, Office of Merchant Marine Safety, USCG
Cesar DeLeon, Acting Director, Office of Pipeline Safety
Vincent J. Esposito, Director,
Office of Vehicle Safety Research, NHTSA
Robert E. Parsons, Associate Administrator for R&D, FRA
G. J. Pastor, Associate Administrator for R&D, UMTA
James L. Foley, Jr., Director, Office of Highway Safety, FHWA
Marion Roscoe, Associate Administrator, FAA (Absent)

MR. BOLGER: We are now going to get to our first discussion area and we will be right back with those alligators, because we will be listening to those gentlemen who day-to-day are meeting immediate safety problems and are up to their ankles in alligators. At this first session we will ask each of these gentlemen for a few minutes' discussion of the significant problems areas in his modal activities and then an outline of a few of the more prominent R&D needs that he can see to meet those problems. If I can ask everybody to hold questions until the end of the discussions by the modal representatives, we will have a question and answer session to see if we can't elaborate on those particular areas that are of significance to you.

With that, I might point out that there are a couple of changes. Mr. DeLeon, who is the Acting Director of Pipeline Safety, is representing Jim Curtis, who was called out of town on a rather urgent mater, and Marion Roscoe, who is the Associate Administrator for Safety in FAA, is not here. He was called away in con- nection with the American Airlines accident in the Virgin Islands

So with that, why don't we start. I will ask our first representative, Rear Admiral Mike Benkert of the Coast Guard, Office of Merchant Marine Safety, to discuss for us marine safety matters.

REAR ADMIRAL BENKERT: Good morning, gentlemen and lady. Before I say just a few words of introduction to the Coast Guard's aspect of this program, to our R&D efforts, and to what we are looking for in the R&D field, I would like to introduce three of the other people that I have here today. They are very easy to spot because they wear a blue suit with gold buttons. Lieutenant Townley works for me in the Office of Merchant Marine Safety and is really directly responsible for the coordination of the research and development efforts we generate in my office for implementation by our Office of Research and Development.

Commander Davis and Mr. Kiehle represent the Office of Research and Development. They are going to be here for two days and would be delighted to discuss the handouts that I intend to pass around this morning.

Now, gentlemen, I think Phil probably put it rightly. He would like us to get up and say just a few words to get the ball rolling. I do not have a prepared speech or a presentation as such, but I would like to discuss a couple of points of philosophy from the Coast Guard regulatory point of view. I would also like to say a few words about the past and a little bit about where we think and hope that we are going in the future.

I think probably most of you, even those of you who are in the academic community, have some idea of what the Coast Guard does. I think, however, some aspects of our regulatory function

in the safety field are probably not quite so well known. For one thing, the program which I run for the Commandant of the Coast Guard is called the Commercial Vessel Safety Program. All of our regulatory activity which deals with the construction, equipment, operation, functioning, manning, and licensing of people on U.S. flag vessels and our appraisal of foreign flag vessels entering United States waters is developed and generated through my office here in Washington and, of course, implemented by a number of field offices that we have worldwide.

I am here today also representing in a general sense another specific regulatory safety field, that of recreational boating. As I am sure you are all aware, from the point of view of control, regulation, and an appraisal of safety, the safety approach to recreational boating in this country is done through the U.S. Coast Guard as directed under various statutes. The latest one, the Federal Boat Safety Act, which was passed just a few years ago, gave us a far greater, I would use the word, "responsibility," with reference to the safety of recreational boating.

In order to regulate, if you will, and I prefer to use the word to "appraise" these forms of transportation systems, we have over the years been involved in a rather large number of R&D efforts. We used to call them a "hip pocket" common sense appraisal of what was safe and what wasn't. In recent years our efforts have become, to my mind, more formalized, more systematized and probably a hell of a lot better than they were in the past because we have called upon commercial organizations, our own in-house capabilities, and the academic community to assist us in looking at problems that are associated with these two facets of water modal transportation, both commercial and recreational, in the United States.

Many years ago, our approach to the safety problems that we have was, and I think Mrs. Connors said this really very well, "technological" in the sense that we have a problem of, for example, people on a recreational boat being asphyxiated by carbon monoxide and a lack of oxygen. We try to find out technologically what happened. We investigate the casualty and we determine how we can better arrange the boat, how we can better install the engine, what kind of a device we can put on the exhaust to eliminate this possibility, or what kind of ventilation we can put into the vessel. To me this exemplifies a very mundane but practical approach to solving a problem. That is, the problem arises and we try to solve it by some form of design or construction or equipment.

Much of our research and development today is still predicated on this kind of a concept. We have a large number of technological problems that still remain unsolved in the recreational and commercial vessel safety fields. In the areas of vessel design, vessel construction, vessel equipment, lifesaving gear, fire-fighting gear, you name it, we are still involved in and still developing new approaches and new equipment in response to technologic advances. We are taking a new look at the same problems, but nevertheless a new look at them from what I would call an R&D point of view. We are looking ahead not only to solve the immediate problem that we see right now as a result of casualties, but also to solve problems that we can foresee arising because of the development of new technologies in the mode of transportation itself.

I would like to stress this latter field, and show you what our thinking has been in this kind of an appraisal. Up

until fairly recently our approach has really been what I would consider a straight-out technological approach. Now, in many ways we have solved a lot of our technological problems with vessels and their operation. This has been going on for years, but today we have new types of vessels, new types of operation. I would just mention a few of them because the handouts I am going to give you pinpoint these areas. I mention particularly the development of large commercial chemical carriers. These are tremendous vessels carrying cargoes which are extremely hazardous, extremely toxic, and environmentally a problem. The carriage of such cargoes as liquefied natural gas and the increase in the importation of petroleum products has led in turn to the development of new types of vessels that are larger, more complex, and more sophisticated. Because of their impact, both safety-wise and environmentally, these vessels need a new look at their operation, at their design, and we need a new look at our methods of controlling the operation of these vessels.

Due to a new technological development, a vast expansion of chemical transport by water and petroleum product transfer by water, we have new types of ships. We have new problems with them. We have different people operating them. We have a need for different qualifications for the people who operate and handle the vessels and the cargo they carry. All of these areas needs a good look because it is the responsibility of the Coast Guard to not only insure the safety of those vessels, the people that ride them, and the cargo they carry, but also to insure the safety of the populace that may be exposed to what can conceivably happen as a result of casualties to those vessels in our waters.

This gets at what we call risk analysis in trying to look at the whole system. In our risk analysis efforts, just to give you a broad idea, we have spent about a million dollars in research money in the course of a few years. This is probably peanuts for some of the outfits around here, but in the Coast Guard it is a hell of a lot of money. The term "risk analysis" to us means how much risk can we stand? For example, if we want energy in this country in the form of imported liquefied natural gas, what kind of an accident can we accept in terms of the possibility of that accident happening? This kind of research is the sort of thing that we have been calling upon the academic community to perform. We have also called upon a number of commercial organizations to assist us in developing an approach to this type of problem, that is, how much can the American public stand or is it willing to stand in order to make sure, for example, that we have a good energy source coming into this country?

My office has been working very closely in this area, with Mr. DeLeon's office, the Materials Transportation Bureau, where we have a joint responsibility for this type of appraisal of an energy source.

Another effort, though I wouldn't call it a new effort, consists of an approach that we have recently become involved in to a much greater extent. As a result of our statistics and accident data which has been made available through some recently developed information systems for compiling and appraising this sort of thing, we have verified, as you might suspect, that the biggest area of problem we have, from a safety point of view, is the people problem. Roughly 85 percent, just as an off-the-top-of-the-head number, of the accidents that we have in the commercial vessel field, are the result of some kind of a people problem such as a mistake, an error, a misjudgment, somebody

going to sleep, or somebody not doing the job which we have considered them qualified to do. From this we start getting into human factors research. We are an operationally oriented organization that has not really dealt in this type of thing before. We are looking for a great deal of assistance in this type of problem area because we don't have a handle on human factors.

We know that a lot of research has been done on this. Mr. Townley, for example, has given me numerous pieces of paper to read on the subject of human factors research and I guess, being an old operational type, I have a hell of a lot of trouble even understanding what they are talking about and in trying to translate this into our methods of appraising people who are operating vessels so that we can either regulate, educate, or train them to do a job properly. This gives us many problems. I think it is absolutely true that our younger people in the service today have a much better handle on this sort of thing than fellows like me who have spent maybe 15 years aboard ship as a ship operator, and have taken the operational and technological approach to problems of this type. We need help in this area, not only specific help to solve our problem, but help from you gentlemen to make the problem more apparent to people like me. This may be a little difficult -- but I mean that in all seriousness.

We also have problems in appraising some of the results of research efforts that we have farmed out to date. We don't always understand the results we are getting, despite the fact that I have some extremely bright young men that sit in on these meetings. The problem is aggravated when they have trouble explaining it to people like me in the process.

I think I have probably talked long enough, Phil, but I did want to say this and particularly emphasize the human factors and risk analysis aspects.

I have had my people prepare a handout* to provide insight into what I mean by nuts and bolts R&D. It will give you an idea of some of the technical areas that we are looking for help in and I hope that some of you would be desirous of picking up a copy. I have tried to put down on a piece of paper the specific individuals in my office who are responsible for these areas. This may be of some assistance to you in taking an overall look at some of the technological aspects of our problems today in this field of marine safety. If you could couple that with the overall concepts of risk analysis and human factors approach which, and I think Mrs. Connors again said this, are a little more nebulous, you'll have an understanding of our R&D effort to date. You can't put a cost benefit type of analysis on that and that is probably where people like me have a problem in understanding what the hell kind of results we are getting for the money we are spending.

Thank you very much.

MR. BOLGER: Thank you, Mike. That was very interesting because I think you touched on a couple of matters which we will be discussing in some detail here. I think your comments on risk management or risk analysis, as you called it, is an area that we are concerned with and an area that we are trying to develop within the Department. We have studies already underway in systems safety with Dr. Pignataro and other organizations, and

* Available from Office of Merchant Marine Safety, U.S. Coast Guard (G-M/82), Dept. of Transportation, Washington, D.C. 20590

it is an activity that we are quite concerned with. I think we will see more activity there.

Your comments about human error are very, very important because if we look at what is going on with our transportation modes and then we start analyzing the accident data, ultimately we get to the biggest problem, which is the human in the system, the human component. If we look at the highway, we seem to be beating the automobile to death trying to make it drive through rock walls and survive it. Yet we are not really getting at the problem. It is the driver, the human in the system, and I think your comments are merely reinforcing that need for greater research in that area.

Our next speaker is Cesar DeLeon, the Acting Director of Pipeline Safety.

MR. DELEON: The Material Transportation Bureau has two broad areas of responsibility, pipelines and hazardous materials. I am more familiar with the pipeline area since I am the acting director of that office. On that side of the shop we have responsibility to issue and enforce pipeline safety regulations. We are responsible for the design, the construction, the operation, and mainte nance requirements for all gas and oil pipelines in the country, including any other hazardous materials that may be transported by pipelines.

There are approximately 1-1/2 million miles of natural gas pipelines in the country and about 1/3 of a million miles of oil pipelines. These pipelines carry about 1/3 of the energy of this country, so it is a very important transportation mode and one which the Bureau feels hasn't properly been addressed by the Department. There is a great potential for developing that mode to transport other products and other commodities. We feel that the pipeline transportation mode is probably more environmentally acceptable than other transportation modes because the pipelines are buried. We feel that the pipeline transportation mode has a very good record as far as safety and economics goes, and we are trying to see that the Department addresses this transportation mode and gives it its proper place in the sun, because we do feel that the future holds a great potential for pipelines.

There are many fertile areas of pipeline research for someone to get involved in. Three principal areas are in the spotlight at the present time. First, there are the offshore pipelines because most of the untapped natural gas and oil reserves in the country are now thought to be offshore. Second, there is a great potential for research involving pipelines in arctic environments. One pipeline is already being built in Alaska. There will be another one starting to be built in the next year or two. Canada is building some pipelines in their arctic environments and the Russians are doing it. There is a great potential for R&D work for arctic pipelines.

The third large problem area for research is on liquified natural gas. The President has said that within the next three to four years we will be importing at least five percent of our natural gas from foreign sources. They will all be brought in to LNG facilities located along the coasts of the country. It is a new technology. It is a technology that holds great potential for those that are going to get involved.

There are other areas. Hydrogen embrittlement and stress corrosion cracking holds potential for R&D for those with expertise in metallurgy, structural mechanics, or welding

technology. We are making great strides in welding technology, especially automatic welding. There are R&D requirements for non-destructive testing, x-ray testing of welds, and plastic pipe technology. More than 50 percent of the pipelines being put into cities are plastic. That also is a new technology developed in the last 10 years. There is a great need for someone to properly address all of the safety issues of plastic pipes.

Odorants is another area in which we feel a great need for research. We have been using the same odorants for pipelines for the last 80 years. We are looking for someone to develop a better odorant because the present odorants do have their failings.

There has been a lot of work done on pipe coatings and cathodic protection to prevent corrosion. Pipe coatings have been put on in the manufacturing facilities as opposed to the construction site. Failures in pipe coating are a great safety problem.

I recognize that the list I have given you on possible R&D areas may not lend itself to the inter-modality that seems to be the thrust of this conference. However, I wanted to give you these areas we felt need addressing and we are looking to those who can come up with good projects to develop along those lines.

With regard to the other side of the Materials Transportation Bureau, the Secretary has authority to determine whether the transportation of a particular form and quantity of a hazardous material in commerce poses an unreasonable risk to health and safety or property. If so, the Department must designate such quantity and form of material or group or class of such material as a hazardous material. The materials so designated include, but are not limited to, such things as explosives, radioactive materials, bacteriological agents, flammable liquids or solids, combustible liquids or solids, poisons, oxidizing materials, corrosive materials, and compressed gases. There has been on-going research and development by the Materials Transportation Bureau, to upgrade the classification and test criteria for the basic classifications so as to provide quantitative criteria wherever possible. This facilitates the proper regulation of the many new hazardous materials that are being developed in this dynamic and constantly changing industry.

In the area of handling hazardous materials, the Department is authorized to establish certain criteria which may include, but are not limited to, such things as qualification and training of personnel, inspection criteria, detection equipment, and facilities specifications. The need for safety research derived from these matters are: First, the possible development of performance oriented packaging specs to replace the present predominantly hardware oriented packaging specifications. Second, the development of practical procedures for the utilization of risk assessment methodology in decision making. Third, the development of techniques and equipment to assist in the detection of hazardous materials in transportation during inspection and enforcement. Fourth, the development of training programs and training aids to assist interested persons such as shippers, carriers, and emergency response personnel, on the routine as well as the emergency aspects of hazardous material transportation.

We feel that there will be other research needs originating from our responsibility to evaluate the risks connected with the transportation of hazardous materials, to establish and

maintain a central reporting system and data center, to provide interested people with technical and other information and advice on hazardous material transportation and to conduct a continuing review of all aspects of transportation of hazardous materials in order to determine and be able to recommend appropriate steps to assure the safe transportation of such materials.

From this, I think it can be clearly seen that there has been and continues to be an ever-increasing need for programs of safety research and development to support hazardous material transportation.

Thank you.

MR. BOLGER: Thank you, Cesar. I think you do have some inter-modal matters there. Certainly the use of risk assessment and the control of these hazards are safety techniques that are inter-modal and I would think that the LNG matter certainly flows throughout the transportation system -- starting in the marine and involving trucks and rail, so it does go across many modes.

We will move on now. I would like to introduce Mr. Vincent Esposito, who is the Acting Assistant Administrator for R&D of the National Highway Traffic Safety Administration to discuss automotive safety matters.

MR. ESPOSITO: Thank you, Phil. Good morning, ladies and gentlemen. Ms. Connor, in her introductory remarks, spoke of the balance between safety research and safety programs. In the motor vehicle and traffic safety area, that translates into a balance between safety research and safety regulation.

Sometimes it seems as though that balance of R&D and regulation has an "Alice in Wonderland" quality about it. If you recall that Lewis Carroll classic, you will know in the last chapter Alice finds herself on trial before the King and the Queen. The King announces, "Let the jury consider the verdict," but the Queen interrupts him and says, "No, sentence first, verdict afterwards." Now, in the safety area sometimes the researchers find themselves in the position of "No, regulation first, research afterwards," and it can be a difficult situation.

The issue here is how much research is enough? Clearly, we cannot afford to put out either motor vehicle rules or highway safety standards without sufficient back-up in terms of hard data to defend them and support them.

On the other side of the coin, we cannot afford to "study the problem to death," because that is exactly what we would be doing. While we are carrying out our research and postponing the implementation of safety counter-measures, people are dying every day on the highway.

How much research is enough? At what point can we decide that we have enough information and support to push ahead with either a motor vehicle regulation or a highway safety standard, or should we stop and study the problem for a few more years before we reach any decision? Here is an issue for you to think about. It is not specific to any particular research problem, but it will cut across all of them, including ones that I am going to mention now.

I would like to discuss a few of the critical research areas that I think you particularly might be able to help us with. I am pleased that of our total research budget, a good 20

percent or more does go to universities. That amounts to five or six million dollars a year. I would like to see a more equitable balance between the money going to universities and the money going to industrial organizations, but it is pretty much up to you all to prove that you can do the job.

One thing that I am not terribly happy about is that when you read the list of universities conducting our research, (and you can get this list by picking up the yellow book* that is on the handout table), it reads a little like the AP's Top Ten football poll, Ohio State, Michigan, UCLA, USC, so forth. I am sure that some universities get the feeling that their chances of getting a contract from us are just about the same as their chances of making that Top Ten football list; but that need not be the case. It is a question of finding the needs of the Agency, matching them with your capabilities, and being able to come in with a strong proposal to do the research. There should be no monopoly of size in the ability to solve some of the problems that we are dealing with.

Let us talk about some of the specific problems that we have, and there are many. One of them, and it has already been referred to by Ms. Connor this morning, is the adequacy of our highway safety data base; that is, the information upon which we make our decisions concerning safety regulations. The decision-making for highway and motor vehicle safety depends heavily upon available statistical information about driving exposure, accidents, injuries, and their consequences. For years we have been forced to depend upon state and local traffic records for the main source of such information, and I am sure you realize the many drawbacks that are there. There is a lack of uniformity, for example, among the data collected by different states for their own traffic records.

This fact was brought home to me in startling fashion several years ago when I was in the Federal Republic of Germany. I was surprised to find that they had a single standardized accident reporting form for almost the whole Federal Republic of Germany. They could gather up all of these accident reports, code and computerize them, and analyze them as they wished. Whereas, just in Los Angeles where Dr. Sherman's staff runs an accident investigation team for us, there are at least 15 different policy jurisdictions, all with their own reporting format.

Police records are not designed, necessarily, for safety research. They are designed to meet the needs of the state and local highway system operations.

In response to these deficienciese some years ago, we set up our in-depth, multi-disciplinary accident investigation teams which did go out and get specific detailed information on a limited set of accidents; a very expensive operation, but a very successful one in the sense of generating good information. We are now trying to strike the proper balance of not gathering too much information on too few accidents and at the same time not trying to depend on very little information on every accident in the country. This is the National Accident Sampling System Ms. Connor referred to that we are just beginning to get underway. A lot of key decisions will need to be made and a lot of help will be needed (some of which can come from the university community) concerning the setup and operation of this system.

* DOT-TST-76-37, Awards to Academic Institutions by the Dept. of Transportation in FY 1975.

A second important area and one that has already been mentioned once, is the balance of emphasis between studying the vehicle and studying the driver. This is one of the paradoxes that we have been dealing with for the nine years that I have been with NHTSA. As a matter of fact, to back up Admiral Benkert's statement, about 85 percent of our accidents are caused by drivers, not cars or highways; and yet if you look at our use of research resources, most of it goes to the vehicle rather than to the driver.

There are reasons for this. It is a lot easier to change vehicles than it is people. Vehicle factors are susceptible to engineering solutions. We can implement them rather quickly, and we can demonstrate their effectiveness quickly and decide whether they are doing what they are supposed to do. Changing the driver is a much more complicated operation; it requires changing his behavior. It is something that we have been studying and we will continue to study. It is an area where we need all of the help that we can get in terms of how to motivate people to change their behavior and how to teach them more than the mechanics of driving a car, which, in fact, is very easy, almost too easy.

We have done very little fundamental research to understand the complex factors that influence driver behavior, why drivers behave the way they do. As I mentioned earlier, the payoff here is tremendous. If you can make small changes in driver behavior, you can have a tremendous impact on the highway toll. On the other hand, these changes are very, very difficult to bring about and we have to be realistic in doing something we know we can accomplish rather than wasting resources on a problem that we just can't solve.

The driver behavior area, I might mention also, is an area that is truly intermodal. What we can learn about driver behavior can be translated, I am sure, into personal behavior of private boaters, pilots, et cetera. In fact, it would be interesting if we tried to do an accident profile of people who have reckless driving accidents and people who have reckless boating accidents. We would probaby find the same sort of people.

A final problem area or research area that I think you would be interested in is our Research Safety Vehicle program. As you know, we have been building safety cars for years, emphasizing "safety," sometimes at the expense of other qualities of performance. The program we are in the middle of now, the RSV, is referred to at least twice in Secretary Coleman's policy statement that you have, as a new approach to the problem. New because we are not considering safety at any cost. We are trying to balance the requirements for safe transportation with the requirements for environmental protection, fuel economy, and total operating economy, or lifetime cost for the vehicle. Now, to achieve this goal (and we have several contractors who are trying to design vehicles that will meet a balanced set of goals in terms of safety, environmental protection, emissions, and economy) you have to make some trade-offs. You have to ask yourself how many miles per gallon is a human life worth; not really in those words, but you find yourself faced with those kinds of issues. How much safety can I sacrifice to get fuel economy? How much fuel economy can I sacrifice to get safety? How much of both can I sacrifice to get environmental protection, and how do you make the trade-offs?

Although we are in this program now with specific contractors, when we begin to evaluate the results of it and

decide how to apply them, we are going to need some additional help.

Here are three areas: (1) the whole highway safety data area, (2) the question of more effective and better research on the driver instead of just the vehicle, and (3) the question of balancing vehicle safety requirements with other vehicle requirements. I invite you to tackle any or all of them. Certainly the impact of motor vehicle and highway safety research touches everybody; and the stakes on the highway are high. The safety problem here is bigger than in any other mode. We cannot afford poor research support for some of the critical standards we have to set, but at the same time we cannot await perfect research solutions before we do anything. I invite you to tackle some of those alligators while you are working this week.

Thank you.

MR. BOLGER: Thank you, Vince. You brought up a couple of important points for us. One is the importance of the individual, the automobile driver, the recreation boater, and the general aviation pilot to safety improvements. Those are areas of our big losses, and there is certainly a common theme throughout. I think that is an area that we ought to be looking at.

The other thing which you bring up that is important, I think, is getting out ahead of the problem. We are constantly coming up with gimmicks to try to solve an immediate problem. We had the Dulles crash, and they wanted to put in a warning system in every commercial airliner, a ground proximity warning system. That is an immediate solution, but had we been looking at that problem way out ahead there may well have been a better way of doing it. The ignition interlock is another example. The fire storm raised by that was, I think, evident to everybody. It certainly wasn't any good as a solution.

These are all good points and I hope people are taking note of them.

Now, our next speaker, Mr. Robert Parsons, Associate Administrator for R&D of the Railroad Administration, will discuss his problems.

MR. PARSONS: Thank you, Phil. Good morning, ladies and gentlemen. It is my pleasure to be here today -- particularly since we in the Federal Rail Administration, along with our counterpart in the industry, the Association of American Railroads, are currently re-examining safety priorities. I don't want to upstage my boss, Deputy Administrator Bruce Flohr, who will address you tomorrow, nor my associate, Don Bennett, who will chair a panel this afternoon on the institutional aspects of transportation safety, but I would like to say a few words with regard to the big rail safety picture. Then I will get into the research aspects. I will also try to illustrate a few of our problems and potential areas for university participation.

I am fairly new in the rail business and inherited a fairly large-sized federal research program, approximately $30 million per year. Since my arrival at FRA, we have been seriously reviewing our priorities. Therefore, I am glad to be here today to inform you that during this next year we are probably going to re-orient some of the programs, particularly those relating to safety. Like the other modes and like the speakers before me, I can also state that railroading has a safety record that could stand some improvement. Unlike the other modes, our industry is sick financially and so we have a double chore:

trying to pump lifeblood back in the economic vitality of the industry and at the same time improve the safety record.

For the last two or three years, we have made progress on our safety record, and so there may be some light at the end of the tube.

What I plan to do now is use a couple of slides to focus the theme of my talk.

SLIDE 1

APPROACH TO RAILROAD R&D
-- Develop sound knowledge base
-- Improve safety
-- Increase movement of passengers
-- Increase the operational efficiency of rail freight

The first slide conveys our approach to R&D. There are two research organizations. I have the hardware side and my counterpart, Martin Zell, Association Administrator for Policy and Program Development, has the software side. We jointly are working in the first area to establish a data base. It is not only developing a statistical data base which you have heard mentioned before, but also involves technology activities to determine the cause and effect relationship of doing something or not doing something. For example, what is the price in terms of accidents, maintenance, and other parameters of increasing heavy axle weights on the rail system?

SLIDE 2

SAFETY
-- Develop regulatory criteria & policy
-- Develop failure analysis
-- Improve safety field work
-- Provide tools for field inspection

This slide shows our safety objectives. Of the $30 million available for R&D this year, about $20 million is for safety. Most of my personal time is devoted in the safety area. Most of my people are working on safety issues. The Administrator and I place highest, by far, of all of our priority on the safety issues.

Our primary R&D safety customers are the industry and our rulemakers. We support the Associate Administrator of Safety to undergird regulations in areas where he believes they must be promulgated. In addition we work with our counterparts in industry, the Association of American Railroads (AAR), to jointly try, thorugh implementing research results, to negate the need for rule-making; that is, to have the industry take needed preventive actions.

SLIDE 3

RR SAFETY TRENDS
-- Train accidents (damage in excess of $1750)
1975 -- 7835 -- an increase of 4.6% over 1974

CAUSE	
Track conditions	39%
Human factors	23%
Equipment failures	24%
All other	14%

SLIDE 3 (Cont'd)

-- RR Crossing -- 948 deaths, 3923 injuries (1975)
-- Train collisions -- 1025 (1975)
-- Hazardous tank car -- $54 million property loss (1974) (1975 data incomplete)

The last slide I will use highlights a few areas that present opportunities for research. This data is derived from our FRA statistical data base and is ranked by number of accidents. We are now questioning whether accidents is the right parameter. Should it be fatalities or injuries? We are also questioning other elements in the data base. At present our research activities are about in proportion to the main causal areas. About 40 percent of all rail-related accidents are track-related and, accordingly, I have about $10 million of federal funds in one aspect or another in track related R&D, to get on top of this area.

It is my opinion that one of the toughest technological issues facing transportation today is the railroad wheel-rail interface. We have a joint program with AAR, and our supply industry, represented by the Railway Progress Institute (RPI) in track-train dynamics specifically aimed at this area. As the economy of the railroads has eroded, they have had to let the track beds also erode and at the same time, to try and keep their productivity up, they have gone to heavier loads. Thus we have a severe dynamic interface between the wheel and the rail. Today some universities are engaged in this area and it probably represents a very fertile field for more help.

The other area in track research where we are spending money is in inspection techniques. We have got a handle on the track geometry devices, which is the way that the railroads and the FRA control the condition of the track. But we have not solved high speed flaw detection. There is needed, from a technological standpoint, a better way to pick up rail flaws while traveling at typical freight-train speeds.

With regard to human factors, there isn't much more that I could add to what has been said by the others. I think that we have similar problems and they are mainly generic to all modes. At present we do not have really good tools to analyze the rail man-machine interface. We have plans to start studies for a device, not really a simulation, that would enable one to test control improvements of a vehicle and assess the impact on the operator's reaction. We have done very little in this field in the past. It is a very fertile area and I think you will be seeing an opportunity for university research activities in this area, also.

Another area I would like to talk about is equipment failures. Today we are working on bits and pieces. As our statistical data analysis becomes more proficient, I think we will see clearer areas of high payoff. Again, it is the same problem that previous speakers have mentioned -- lack of a good data base and analysis.

Grade crossings have also been a problem, for longer than any of us have been here on earth. But fatalities are coming down. This appears as much an institutional problem as it is a technology issue. As for technology, we were doing research in the grade crossing hardware because we didn't see the private sector doing that. Recently we have been asked to get out of that area by the suppliers, which we are doing.

Through some federal seed money, we have established an industry interest to reduce the cost of this equipment. The safety statistics from last year to this show a fairly sizable reduction in fatalities, but it is still too big when one looks at the overall rail system. The number of people being killed at the grade crossings is still too large.

In the transport of hazardous materials, our prime activity has been in the large tank cars. The concern is about the chain reaction that could result if one explodes and results in a fire that could cause explosions through an entire train of tank cars. We are just about to solve the tank car problem jointly with the industry. There is a need for low cost thermal shielding or insulation materials to buy time so that the hazardous liquid can vent rather than explode. We plan to provide end protection to prevent coupler puncturing.

To summarize, as far as priorities go, the first is to establish a good data base and methods to prioritize R&D tasks. The latter could either be risk analysis or other ways of ranking tasks based on that data base. I believe this is a field where we could use the expertise from the universities. It is common to other modes as well. Next is modeling in the track-train dynamics interface as well as our crash survivability testing. In the past we have used universities and could use more assistance in the modeling aspects. In flaw detection, which is a narrow technology area, we need ideas as to how to inspect track for flaws at freight train speeds. Rail, like the other passenger carrying modes, needs safer internal materials, particularly low cost fire resistant types. Lastly, like the other modes, human factor R&D is a fertile field for safety improvement.

I thank you.

MR. BOLGER: You did highlight one point which is another one we are trying to dwell on. That is the institutional problem. I think George Pastor may also touch on that, since we have a real problem when it comes to the railroads, the rail transit, and the transit bus. FHWA and NHTSA responsibilities are within the same area. A particular administration buys and uses the equipment and a second administration sets the regulation so there are those institutional problems.

George Pastor, Associate Administrator of UMTA, the Urban Mass Transportation Administration. George, do you want to give your problem areas to us?

MR. PASTOR: Thank you very much, Phil.

I am sort of a new kid on the block, being in charge of UMTA R&D for close to two years, but last year I inherited the responsibility within UMTA for the entire safety program. I think DOT has demonstrated its dedication to both R&D and safety when, during the past two years, they assigned Bob and me in FRA and UMTA. We now have a Parsons and Pastor, so we have <u>faith</u> in R&D.

My former colleague, Dr. Gene Mannella, used to say about NHTSA that they were a bad news agency, and I could see why he said that. Everybody was against them because of all of the regulations. UMTA is sort of a good news agency. We are best known for dishing out money. However, in connection with dishing out money, we have an implicit responsibility throughout the authorizing legislation to see to it that for that money we install safe systems, safe equipment, safe vehicles, and have some

responsibility for transportation safety. This was made a little more explicit in the '74 National Mass Transportation Assistance Act, where we were, for the first time, even given responsibility to investigate and ascertain the safety or non-hazardous situation of transit systems in the country and could withhold funding if we found any violation.

So when I inherited the safety function, I looked at what is really our role. I divided it up into five functions that I will define here very quickly because it should be some assistance to you in seeing what are the opportunities within UMTA.

First of all, we have a role in safety policy and regulations. We are not a regulating agency. That is done by others, but we do participate in the issuance, review, coordination, and enforcement, of regulations issued in the rail area by FRA and in the non-rail area by the Federal Highway Administration and NHTSA. We now are considering some additional role, perhaps development of guidelines to go beyond some of these regulations when we feel that they may be inadequate for our problems in transit. I will come back to that later.

Then, in view of the new act, we have a role to participate in the investigations, review and enforcement of the FRA, Federal Highway, and NHTSA regulations and, indeed, withhold funding if we find some violation.

In our more traditional role we have a third function: to provide assistance to local properties to enable them to institute and develop safety plans and programs. We raise their safety awareness and consciousness within the transit properties. To assist us in doing this we also instituted a safety training program in the Transportation Systems Institute in Oklahoma City. We are now preparing courses, with participation from academia, industry, as well as the operating industry, to further raise the consciousness and the skills of the transit operators in safety.

Last but not least, we have a role in R&D: to support policy and the other part of the programs. I divide that into two groups. One is the necessary reviews, analyses, studies, and requirements studies to find out what else do we need to do and to support some of our positions vis-a-vis regulations and program decisions. The other is to do R & D to meet those needs and requirements in the areas of equipment, procedures, processes, management and attitude.

This latter is usually known traditionally as R&D. We had an R&D priorities conference for the first time. It was a national conference held in February. It was sponsored by UMTA and APTA (American Public Transit Associaton) and we got together both with the operating and manufacturing industry people and other representatives of the constituency. What came out of that may be the most striking result to me. Many of us knew it, but let me stress, there was a consciousness that R&D should go far beyond hardware R&D. The operating techniques, the social-economic impacts, the human factor aspects, the processes, the attitudes, are probably more of a problem in urban transit than is the technology.

By the way, the proceedings of this R&D priorities conference, which also will indicate some of the specific needs, will be available soon. Those of you who are interested should contact the APTA headquarters here in Washington for a copy. It will have some examples.

Within this R&D environment, I would like to give you a few specific needs. First of all, based on the Congressional hearings, there is a tremendous security consciousness. I realize the difference between safety and security, but then again, the viability of transit in our urban areas depends to a great degree on improved security, so I commend that to your attention.

In the more traditional safety R&D areas, what we see are similar problems to those Bob mentioned. We work with Bob and with TSC (Transportation Safety Center) frequently; we already have programs in safety and in crash-worthiness. We are watching Bob's program on track safety and we intend to supplement it with an effort oriented to specific urban track problems which may be slightly different from the problems that he is addressing.

There is a conflict of cultures, railroad and transit, primarily when it comes to automatic train control or automatic train protection. There is the old, well-established railroading culture which clashes with the aerospace culture of recent days. The entire concepts of fail-safe, fail-operational, all predicated in the railroad industry on well-proven, reliable hardware, conflicts with some philosophical approaches that the aerospace community is trying to introduce. We need documentation, definition, and resolution of problems such as: "what is fail-safe?" "what does automatic train control do?" "what are the benefit-cost ratios?" We need to document the benefits of well-established practices versus innovation. This is a fertile field for research and development.

Last month, we announced that finally we are dedicating ourselves to the principle of railcar standardization. In order to come up with some standardized national urban railcars, it behooves us to know what is reliable equipment to standardize on. There is a scarcity of data, documented data, on equipment reliability and maintainability. Now, I know good reliability and maintainability does not make for safe systems, but certainly poor reliability and maintainability can make unsafe systems.

I also would commend to you very strongly to look not only to the federal government. Especially in the UMTA area, the decision-making is at the local level, and I think the locals need academia even more than we do. I think there is a tremendously fertile field. You are in local communities. You have your relationships. I know APTA has a new awareness of their negligence in tapping the academic resource. I think it is essential that you establish bridges, links, with your local transit planning and operating communities, because you can give them help not only in the technological R&D but in the processes, in their development of safety consciousness in plans, programs, techniques, analysis, and support.

A very good example right now is brewing down in Dade County. We just gave a grant to Dade County to start the engineering potential for a rail line in Miami. There is talk and planning going on right now to adopt some of the NASA risk management philosophy techniques developed for the space program to be applied to the implementation of that rail system. Many of you are just as much part of the aerospace program, or maybe more, than of the transportation program. Technology sharing can very well start with you.

Thank you.

MR. BOLGER: Thank you, George. Your comment about definitions is interesting. I remember when Secretary Volpe sent us out to look at BART. I, arriving with a background in marine, aviation, and space, started talking about "fail-safe" and I ran into a buzz-saw. I really got chewed up by the alligators because I didn't know what I was talking about as it related to transit operations when I was talking to people who have been in that field all their lives. I had to learn.

Our next speaker, Mr. Roscoe, was sent by his Administrator, Dr. John L. Lucas, down to the Virgin Islands on an accident investigation. We just got the word, and so, unfortunately, he will not be here. However, his comments have been prepared and will be in the proceedings of this meeting.

MR. ROSCOE: (Prepared text inserted.) Safety research with the objective of advancing the state of technology for improving safety methodology is vital to FAA's aggressive program of promoting safety in air commerce and for revising safety standards that will best tend to reduce or eliminate the possibility of, or the recurrence of, accidents compatible with promoting the development of air commerce.

Our safety programs stress accident prevention through identification, reduction, and control of hazards, and emphasize integrated efforts directed at preventing, reducing, and controlling accidents by human, equipment, or operational factors.

There are two basic assessments that must be made in deciding to implement safety improvements. One is that it must be within the resources allocated to air safety, and the other is one of economic impact, a determination of risk versus the cost of less risk as it pertains to fostering the growth and development of air commerce.

The continuing downward trend in aircraft accident and fatality rates for both air carriers and general aviation in the past ten years with substantial increases in air operations and air passenger miles traveled is indicative of progress made by the FAA and the aviation industry in improving safety of flight.

In spite of the excellent safety record of the past, accidents continue to occur. That fact plus the ever increasing growth in carrier aircraft makes it essential that further improvements be made if the safety record of the past is to be maintained or improved. Fortunately, advances in the state-of-the-art of related technology continues to provide new opportunities for solving safety problems which were not previously solvable through technical development. For example, the safety program associated with high energy wake vortices generated by large aircraft was first alleviated through the use of larger separation standards which in turn reduced airport operating capacity. Today's technology now makes it possible to explore ways to detect the presence of such vortices and possibly provide the basis for safely reducing separation standards under certain conditions and regaining lost airport capacity.

FAA's Research and Development program includes many other examples of activities for which one of the primary goals is improving safety together with reducing cost and improving performance. These activities can be grouped in three categories:

1) Reducing aircraft accidents
2) Reducing fatalities and injuries following aircraft accidents
3) Reducing in-flight fires and explosions.

Among the sub-activities in these categories, the following areas are of primary interest for improving safety performance:

1) Approach and landing accidents
2) Midair collisions
3) Severe weather accidents
4) Crew and passenger protection
5) In-flight fires and explosions

The following discussions of safety-related requirements indicate where improvements are needed and provide some insight as to the nature of those requirements.

The safety requirements for reducing landing accidents include the development of techniques for helping insure that the pilot does not descend below a safe altitude and for the development of precision approach guidance which can be installed at locations where the installation of today's standard VHF ILS system is not practical for technical or cost reasons.

The current ATC system and procedures have been effective in avoiding collisions where both aircraft were IFR and under the control of the ATC system. The midair collision problem is primarily concerned with condition where one or both aircraft were VFR and not under the control of the ATC system.

Most enroute accidents occur as a result of encounters with violent weather (turbulence and/or icing), or as a result of crashes into the terrain during poor visibility. Thus, the safety requirements are associated with means for assisting the pilot in the avoidance of turbulence and icing and in the avoidance of the terrain during controlled flight at low altitude.

The safety need is to provide assistance to the pilot in the avoidance of violent weather. In some cases fatalities occur as an immediate result of a violent crash and are not avoidable other than through the avoidance of the accident itself. In other cases, injuries and fatalities occur after the accident due to trauma, burns, or asphyxiation resulting from carbon monoxide or toxic fumes. Some of those casualties occur due to an inability to escape from the aircraft.

The nature of such casualties which occur following an accident emphasize needs to:

- Improve crashworthiness of the aircraft to provide better protection to the aircrew and passengers.
- Provide for interior aircraft design and safety features to avoid or minimize trauma.
- Reduce the chances of fire.

The statistics on accidents resulting from fire, explosions, and sabotage is a tribute to the aircraft manufacturers and designers that accidents due to these causes are so few and account for less than two percent of the fatalities. Nevertheless, continued increase in the thrust of aircraft engines and the accompanying higher operating temperatures make it necessary to maintain a continuing study of the causes of in-flight fires and explosions and to develop means of further reducing such accidents.

In addition to the fires which might result from the operation of the aircraft, there are also fires and explosions due to hijacking and sabotage which must be guarded against. The rash of hijackings and attempts to sabotage which began in the late 1960's established requirements for the detection of weapons and explosives which might be used to threaten the lives of passengers and aircrew. The actions taken by the government during recent years have helped reduce that threat significantly, but requirements still exist for improving ways of detecting explosions and for their disposal in flight.

Other areas for safety improvement involve the take-off regime of flight and repetitive general aviation accidents. The requirements for reducing such accidents are basically requirements for improving pilot proficiency and safety awareness. In general, it does not appear that the majority of the causes of such accidents are amenable to solution through technological research activities. The need is to develop data to support changes in rules and regulations which might help achieve and maintain a higher level of pilot proficiency in preflight procedures and in improving certfication standards for new aircraft designs and to avoid design induced causal conditions such as locked or misaligned control surfaces.

Many small general aviation aircraft accidents are non-weather involved and accidents occurring during high risk flights. Our activities addressing this problem are associated mainly with the development of rules and regulations which could improve pilot performance and with improvements of the stall characteristics of small aircraft.

Other safety improvement needs which are not identifiable with any one phase of air operations include avoidance of pilot impairment due to physical condition. The fact that NTSB accident reports frequently mention pilot performance as a cause or factor is evidence of the need to continue to develop means for improving pilot training, upgrading certification requirements, and assuring retention of proficiency after certification. The accidents and fatalities due to pilot impairment indicate the need to continually study ways to insure that the pilot is physically sound and that the biomedical factors are considered in safety-related facility design and in FAA safety rules and regulations.

We would like to see more studies on the effect of jet-lag and fatigue on the alertness and awareness of flight crews and on length of crew layovers to permit readiness to function at peak efficiency on their next flight.

We need studies to better understand the human performance involvement in the causation of aircraft accidents.

Perhaps the data collected in accident investigation which is the major data source for studying these problems should be expanded. If so, what is needed?

Do we have a realistic measuring system to gauge safety performance and to assess safety requirements in terms of the state-of-the-art and economics, in balance with an acceptable level of risk for the different classes of aviation operations?

The foregoing may suggest areas for research proposals that could facilitate our mission of providing the highest practicable and feasible level of safety for people, property and the environment associated with or exposed to the National Aviation System.

MR. BOLGER: Our last speaker is Jim Foley, the Director of Highway Safety for the Federal Highway Administration. Jim, would you close off our session?

As soon as Jim is through, we will take as many questions and answers as we have time for.

MR. FOLEY: Thank you, Phil. Ladies and gentlemen, I believe all of you know that the highway accident is a rather complex event. It involves the driver, the vehicle, and the roadway. In looking at the results of the multi-discipinary accident investigtion studies, it is apparent that at least two of these factors failed in any highway accident and very frequently all three.

A classic example of that, I believe, is a bus accident that happened in Pennsylvania a couple of years ago. A bus with two bald tires which happened to be on the same side of the rear axle and a driver who was not qualified to drive a bus hit a piece of highway that had a little water on it at the bottom of a hill. He wasn't able to cope with it. It is my view that, had any one of those three factors not been there, the accident probably would not have occurred and a number of children would not have died.

Our problem in the Department, basically, is to look at highway transportation safety with the objective of reducing the losses in terms of fatalities, injuries, and property damage. The Federal Highway Administration has two aspects to worry about. One of them is the environment, or the roadway on which the driver travels. The other is motor carrier regulation which governs the motor carrier industry to assure safe operation.

We share this responsibility within NHTSA. NHTSA, with respect to the state programs, is concerned with the driver and the vehicle and we are concerned with the highway. In the motor carrier area, our concern is with regulating the driver and the company that he works for while NHTSA regulates the industry that supplies the vehicles.

Getting to the highway, our objective is to provide the most "forgiving highway" environment possible within the funds available. We know that vehicles break down -- maybe because of mechanical failure or poor maintenance or something like that, and we know that drivers do too. That has been alluded to this morning. Mike mentioned it as part of the recreational boating problem and Vince identified it again in NHTSA's area. Drivers sometimes fall asleep at the wheel, or maybe they have had too much to drink, or maybe they just haven't learned how to drive properly.

At any rate, it is our view that in those instances, if one of them does fail, we should not be exacting the death penalty. Therefore, our position is that the highway can mitigate those problems. We like to try to provide, as we say, the "forgiving highway". We can do it, but it costs money.

The Interstate System last year had a fatality rate of 1.8 deaths per 100 million vehicle miles of travel. That compares with the national rate of 3-1/2 fatalities per 100 million vehicle miles in 1975. We know we can solve some of these problems by improving the design. The Interstate System demonstrates that.

The other areas that we are very interested in, and these are hardware problems, are break-away signs and impact attenuators. What we need to do is find out where to put these. Because we have about 3.8 million miles of highways in this country, and cannot at this time afford to fully protect every mile with a clear roadside or all of the attenuators that are needed, we need to have a system to find out what to tackle and what to tackle first. That is one of our big problems. The other area is to find out where we can get the most cost effective activities accomplished. That theme has shown up a couple of times this morning and it is an area where you can help us. We don't have all of the data we need. As a matter of fact, data has been cited at least three times this morning as one of the problem areas and we have found that applies equally to the Federal Highway Administration.

We know we don't have all of the answers. We do know many of them and also that research properly applied can help us find better ways, and I think this is where you can help us.

Let me throw out a few questions that we think need answers. These are non-hardware-type questions. We have a lot of work going on in the hardware area, so we are not talking about that today. We need to know what kind of data are required for effectiveness evaluation or impact evaluation: what kind of data should we be getting from the police accident reports? Vince Esposito mentioned them earlier. There are 35 different communities in the Los Angeles area, I think was the number he used. Probably very few of them give us the information we need. This is an area in which we could stand some standardization.

Can you develop computer programs to utilize these data and help us do a better job of analyzing them? How can we aggregate data for counter-measures on low-volume roads? I mentioned that we have 3.8 million miles, about 3 million of them are what we would call low-volume roads. They account for a substantial number of deaths, but on a per-mile basis they are pretty low, and we can't identify, at least with the present techniques, the various kinds of problems that are occurring on these roads. Saying it another way, what is the minimum information that we need to tackle that kind of a problem?

Can you develop hazard rating formulae for high-hazard locations, narrow bridges, clear roadsides? We have already done that with the help of the railroad industry as far as grade crossings are concerned.

Can you develop surrogates for us? Now, this is, I think, an area where we can do quite a bit. We don't want to wait until a fatality occurs before we start trying to solve the problem. The last question that occurs to me is can you find out the psychological effect of the various design features? I am probably not saying that properly, but, for example, does the tangent run-out in advance of a curve signal the driver that he is approaching a curve and a curve to the right? If this is true, then do our high-crowned roads give him misinformation?

The answers to these and similar questions can provide us guidelines and a basis for our program development in the construction side and the safety program side. As you can tell, data is an extremely important element for us. It has been said so many times this morning that it is beginning to sound like a broken record.

Now, our other responsibility is motor carrier safety. In this area we are trying to find ways to minimize commercial vehicle losses involving interstate commerce. We regulate the truck and bus industry. The Bureau of Motor Carrier Safety regulates the driver. They set physical requirements. They set hours-of-service rules. They regulate the companies. They check the condition of vehicles. They inspect the records to make sure the companies are working at it. They have the reponsibility for regulating hazardous materials on the highway. With respect to this, my new Associate Administrator, Mr. Anderson, has made two trips to Baltimore to review procedures that the Coast Guard is using in hazardous materials. Thus, we are beginning to work on the inter-modal approach.

Commercial vehicle accidents do not present the number of problems that the passenger car does to us on the highway, but the size of the vehicle and its potential for catastrophic damage requires special attention. The Bureau performs its functions by issuing regulations. The regulations are binding on the industry and binding on the drivers. Consequently, they affect the cost of doing business and they affect the livelihood of the drivers. We need very solid bases for issuing regulations. If we issue a regulation that is on soft ground, all of a sudden we have lost it. I think this is an area that research can provide the kind of support that the Bureau of Motor Carrier Safety needs for setting its regulations and for supporting its rules. These are the kinds of questions that you might address in this area.

There are certain kinds of cargo that are subject to shifting. What does this shifting or slipping do to the controllability of the vehicle? Can the shifting be prevented? They have tended to just tie cargo down a little tighter, but when you have lumber, for example, the board in the middle of the pile has some way of slipping out and all of a sudden the whole thing collapses. What kinds of devices are available to keep drivers awake? We have a 10-hour rule but we have no control over what drivers do before they come on the job. Are such devices effective? There are a number of them that have been suggested. A few years ago we had six devices proposed to improve the controllability of the heavy vehicle. Our initial view of them was that none of them really did the job. However, when research dug into it a little bit they found that one did help, one was neutral, and four of them made conditions worse! These are the kinds of problems that we would like you to look at.

Does physiological deterioration with age measurably affect the commercial driver's performance? We have regulations regarding the young driver. We have a minimum driving age. Should we have a maximum age? What are the legal and ethical problems for the Federal Highway Administration if we were to try to license or certify physicians who examine drivers? The Federal Aviation Admnistration does this for pilots. We have millions of commercial vehicle drivers. Should we be doing the same thing? What would be the advantages and disadvantages of this?

Are fleet safety programs effective? What do effective programs cost and what are their benefits, monetary and otherwise?

The answers to these questions will enable us to develop and promulgate better regulations and thereby reduce the objections from those who are regulated. Loss reduction is our goal. In the highway area data is the big need. In motor carriers, a solid base for rule-making is our need. You can help us find the

best ways and when you do, you will help us support the Secretary's objective cited in his National Transportation Policy.

Thank you.

MR. BOLGER: Thank you, Jim. I would like to comment on two things. Your comments on data reinforce their importance and we really need help on what kind of data do we need and in what form because we are constantly faced with a need to support our decisions. Certainly in rule-making I see it every day. It ends up in the Office of the Secretary with one man saying one thing and the other one saying something 180 degrees away, all based on the same data. I know there is a real need there.

The second comment about design effects on operator performance is very important. I think that is an area where we can really look for some help. What is his reaction, his response due to the design of the system he is operating? It reminds me, if you will give me a moment, of the old story when I learned how to fly an airplane. The planes had a little warning horn which sounded if your wheels were not down when you throttled back to land. A fellow came in to land with his wheels up and the tower called him saying, "Hey, your wheels are up, your wheels are up." He crashed. Afterwards, when they asked him, "Why did you land?" he said, "Well, I couldn't hear the tower calling me because of that blasted horn."

We are almost through with our time, but we would like to solicit any comment or question from the floor. Is anybody interested in posing a question?

MR. WAKELAND: I would like to ask Vince Esposito a question. I am with the National Transportation Safety Board. You mentioned your upcoming work with a research safety vehicle and I believe you said that you were going to decide how to apply the results of this research project. Is there a strategy now or one that is published at present on how the results from the balanced RSV would be applied? If so, where can we get it?

MR. ESPOSITO: Your question is a good one, Henry. We face this with every research project we have, what do we do with the answers when we get them? I might say first of all what we are <u>not</u> going to do. We are not building the ideal car so that when we are finished with it we will tell the industry to build this car and sell it to people as is. We are trying to prove that you can have safety, economy, efficiency, and environmental protection all in the same vehicle. The application of specific features in terms of highway safety will come through the rule-making process, just like any other regulation.

Your specific question is do I have a written plan that says this feature will go here and this feature will go there? I do not. But certainly, if we can establish that certain levels of safety protection can be achieved without dramatic weight penalties, this is something that can be translated into fuel efficient, safe on-the-road vehicles. We feel that both of the designs that we are working on now will be able to show that you can achieve higher levels of safety without a weight penalty and, although we are not going to tell the industry to build its car the way we built ours, we will be able to tell them in the regulatory process that they can't use as an excuse for not building a safer car the fact that it will require more weight. It is a little bit of an indirect application.

The same thing with fuel economy. If we can show that

you can build a safe, satisfactory car, and it still gets 30 miles to a gallon and can carry four or five people, it will help back up our regulatory requirements in terms of requiring certain miles per gallon goals in certain times in the future.

MR. BOLGER: Vince, isn't this an example of R&D to support the rule-making as you move down the road?

MR. ESPOSITO: That is right.

MR. BOLGER: The feasibility part of it, practicability.

MR. PIGNATARO: A question to Mr. Pastor. I certainly agree that the local agencies are in greatest need, but there is the dilemma that the local agencies are most strapped for funds to carry out these kinds of analyses and studies.

MR. PASTOR: You are right. However, as you might know, but it is germane to mention, recently when I acquired the safety responsibility within UMTA, we also shifted the responsibility for the UMTA university research program over to Ken Orski, primarily in recognition of the fact that what we are looking for under the UMTA university research program is not so much technological research but rather to tap the university resource into UMTA's policy-making, UMTA's entire activities, as for example, in connection with alternative analyses, or in connection with local planning. I am certain that starting practically immediately our own university research program will be much more amenable to provide funding for cooperative projects between the local transit industry and the local universities.

MR. DEVORE: One of the things that I did not hear when the gentleman from the Coast Guard made his presentation, was a factor that seems to be related to a lot of boating accidents, and that is weather. The same thing is a factor in general aviation and probably the most inaccurate information the pilots receive, as I understand it, is the weather information, and I wonder if there is anything being done to update that or to provide a better ---

MR. BOLGER: Well, there are efforts with the new flight service station system, the automated system, to improve that. I can't really tell you how well it is going to perform, but you are absolutely correct in saying that that is one of the large causal factors for general aviation certainly. I would say in the civil carriers it is not really a problem, to the order of magnitude that it is in general aviation, but it is certainly an area that does need some examination, and I know that one of the universities did submit a proposal on that subject in the last call for them. I think it was the University of Pennsylvania, or Penn State, excuse me, but it is recognized as an area. It is one that the FAA is concerned with.

As usual, general aviation seems to get a little backseat treatment and one of the things that we have to do in the Office of the Secretary is kind of push on that a little bit.

MR. RUDICH: May I amplify your remarks slightly just to give you a figure? The percentage of involvement of weather in general aviation accidents is on the order of about 55 to 60 percent, which is a very significant number.

MR. BOLGER: Yes, there was a study we did a couple of years ago in general aviation safety. If you are interested, just give me a call at my office next week and I will get you a

copy of it. It does identify that problem.

MR. J. MARGOLIN (George Washington University): I wonder if one of the big gaps in this whole question of safety is not the absence of a listening mechanism in the agencies or the agency, and I carefully say "agency" because of what probably is a lack of communication between elements in the Department as a whole. One of the things that comes to mind very sharply, because we have offered a word on this, is the cues that have been forthcoming from the public, from insurance companies, and so forth, with regard to the small car. Let me use that as an illustration. A few years ago, if you owned a small car, you may have noticed that you had favorable insurance rates. You don't have them any more and the insurance companies are telling you something.

More recently, we have noted that there has been a somewhat rapid increase in the inventories of small cars accumulating on dealers' lots. Now, this is after the agency and the manufacturers of automobiles have been pushing very hard for the sale of small vehicles and subcompact or compact cars. The reason why they are not buying, according to our research, is that people are afraid of them. You find that out from the drivers, the potential buyers. You find it out from the emergency squads and police who know that a small car is a safety factor and some of them are worse than others. Yet, you don't hear the Agency raising some question. It doesn't seem to hear the cry that is coming out from various sources within the public and the public's various institutions which suggest that maybe there needs to be a sensing device somewhere in DOT or in one of its several component agencies which would suggest that you have got some problem areas here. There are a lot of other reasons why people aren't buying small cars, but not the least of them is the factor of safety.

MR. BOLGER: Let me offer one comment. We do have a lot of advisory committees, you know, which represent the public as a whole. In fact, Dr. Campbell is chairman of one of them, and that is an effort to get that kind of feedback, I believe. It is certainly one way. Another way is the type of meeting we are having right here. However, it is a problem continuously. There is no question about it.

What we understand is that people just forgot about the gas prices and want to go back to big cars. That seems to be what General Motors and Ford tell us.

MR. ESPOSITO: Well, we are certainly sensitive to the safety problem with the small car. In fact, if you were to look at our research program in motor vehicle crash-worthiness over the last few years, we have re-directed it from the large to the small car very quickly and the bulk of our work now is in 2,000 pound cars and maybe slightly higher than that class. If we can solve that problem then it is easier for a large car.

MR. BOLGER: I might add that in our deliberations on the push for the use of twin-trailer trucks, the thing that is troublesome is that the record shows that they are as safe or safer than even the single trailer truck. The thing that is kind of stopping us is that in an accident the fatalities are generally a lot higher because of the weight differential between the small car and a larger truck.

MR. ESPOSITO: Precisely.

"DRAINING THE SWAMP"
A DISCUSSION OF SAFETY RESEARCH TRENDS AND
TECHNOLOGY BY UNIVERSITY RESEARCH SPEAKERS

Dr. Michael J. Rabins, Director, Office of University Research, Chairman	"Introductory Remarks"
Dr. John V. Grimaldi, Director, Center for Safety, New York University	"Control of Harm: Research Needs for Understanding the Control of Hazards and Formulating Wanted Solutions for the Problems."
Dr. B.J. Campbell, Director, Highway Safety Research Center, University of North Carolina	"The Dangers of the American Road: Traffic, Terrain, Weather and Other Factors Affecting Transportation Safety Needs and Possible University Research Work Addressing Them."
Dr. Louis J. Pignataro, Head, Department of Transportation, Polytechnic Institute of New York	"Transportation Safety from a System Viewpoint: How Transportation Safety Was Studied Up Until Now. Need for a Systematic Approach. What Is System Safety Methodology? A Look Toward the Future."
Dr. Herold A. Sherman, Executive Director, Institute of Safety and Systems Management, University of Southern California	"What To Do with the Alligators?"

MR. RABINS: Before we get to the "swamp drainers," I have a few observations concerning the alligator nipping at our ankles.

First, I would like to comment that Judith Connor's brief remarks on the style of executive action in government and the way in which executives have to make decisions were exactly appropriate and apt. There is a lesson to be learned from her remarks for university researchers coming to the government with proposals to do funded research. Coming from the outside, as I do, into the government, just a few brief months ago, to head up the Office of University Research, I can tell you that I have been very quickly educated to appreciate her comments. When we, from the universities, come to government to work with people in the bureaucracy, and I use the word "bureaucracy" in a good sense, we must empathize with those problems that Judith Connor highlighted: the pressures and the daily stream of crucial issues that come before people like her and John Snow. We must offer help on precisely those crucial problems facing the decision-makers, those that you are petitioning to fund your research, and be able to contribute to the solutions that they are looking for.

For example, one of the issues that was cited earlier today was that of policy-making and how universities can contribute in policy making. Policy leads eventually to action which might result in Congressional Acts, regulations, or guidelines that are sent out to industry for development of hardware.

DR. MICHAEL J. RABINS, DIRECTOR, OFFICE OF UNIVERSITY RESEARCH
INTRODUCES UNIVERSITY SPEAKERS

Help is needed between the policy development and the action because formulation of policy is not done in a vacuum. There must be a sound data base. Universities can help us understand causal factors. When the development of a policy is to be followed with an action, the universities can best contribute by demonstrating a specific typical path that we could follow between every policy that is emerging and the desired action.

There has been a great deal of research going on for the past few years on automotive energy goals, which is helping the current development of the automotive goals for 1980 and beyond. Those goals could not emerge without the help of both university and industry-based research demonstrating that certain goals are attainable. To be even more specific, one school in particular, Stanford University, under contract to the Department of Transportation, has demonstrated that the myth of the conflict between emissions improvement and energy savings can be debunked. By using a very specific approach, both energy savings and improved emissions can be achieved simultaneously. The particular development that is currently under research involves automatic feedback of spark timing based upon peak pressure measurements in the cylinder. This is being done with electronic fuel injection systems. This is an example of the role of universities; by showing that in developing a policy, there are ways to implement it. The researched solution may not be the only way, but it is a possible way to move from the policy to the action.

My last comment before introducing our speakers is probably a bit of heresy, and coming from academia it may almost be sacriligious. I believe that the universities can contribute most effectively in their research by fighting the alligators while they are doing research on draining the swamp.

I am a little bit uncomfortable with separating the alligator fighting from the swamp draining tasks. I believe that the most effective research that has ever come out of the universities has been the research that is both at the forefront and simultaneously is at the cutting edge of whatever is being done in solving today's problems. An excellent example of this dates back 30 years to during and immediately following World War II. It involves the efforts at the Lincoln Laboratories and Radar Labs at M.I.T. While they were doing far-reaching research and long-range development in the area of automatic feedback controls, they were also using this in developing weaponry, in gunnery control, and in inertial guidance systems. Hardware was going out the back door as the research was being done, and yet the results of the theory developed then are still being continuously built upon and applied 30 years later.

So much for alligator fighting and swamp draining. I hope I have not put our four panelists on the spot and misdirected you too much. Let me give a common introduction to all four. They are all Ph.D's. They are all professors. They have all published extensively. I believe it averages to something like 2.25 books per panelist. The number of their other publications is extensive. If we laid out all of the publications and books of our four panelists, they would probably go from one end of this table to the other end. If we stacked up the honors and certificates I think they would come close to the ceiling.

Our first speaker today is John V. Grimaldi, who is the Director of the Center for Safety and the Chairman of the Department of Safety Education. A professor of occupational safety and health at New York University, he has been there since 1967. He

has worked with the Grumman Aircraft Company, with the Association of Casualty and Surety Companies of New York, and also he has been a consultant to the General Electric Company. When he was with the Association of Casualty and Surety Companies, he developed a document entitled, "A Guideline to the Employment of the Physically Impaired," which is a "best seller." I believe the latest count is 200,000 copies in distribution.

He is an engineer, an educationalist, and a consultant, and he has wide experience in hazard control in the United States and Latin America. He is also a consultant to both major corporations and government agencies. Dr. Grimaldi.

DR. GRIMALDI: Thank you, Mike. As you know, university types are geared for two-hour presentations and 15 or 20 minutes leaves me feeling like the Egyptian mummy pressed for time. We have had a couple of good stories and I don't think they should stand alone. This one is more or less indicative, however, of what I am going to say, so it isn't just to try to add some humor to what probably is going to be some very dry remarks from me.

We in universities are like the cockroaches in the bees and cockroaches story. The cockroaches were very unhappy about their way of life. You know, they feed off of the crumbs of humans and they live in damp dark places. One cockroach, a little bit more adventurous than the others, got outside and he saw how the bees lived. He reported back to his colleagues that this was really a very nice way of getting along. They formed a policy group, not unlike, perhaps, the one that we are convening this morning, and they decided that maybe the thing to do for them was to find out how the bees got to their high status. A delegation was sent to the Queen of the bees. She listened to their problem and said, "Well, this is something I have never had to consider before. I will tell you what, come back on Wednesday and I will give you my answer as to how you can solve your problem."

Wednesday came and the cockroaches, now in great anticipation, came to see the Queen of the bees and said, "Oh, mighty Queen, what do you have in the way of a good word for us?" She said, "Well, you know, I really shouldn't have taken these several days to come to a conclusion. The answer is a very simple one." The cockroaches looked at each other and said, "Well, what is the simple answer, mighty Queen?" She said, "The thing for you to do is to become bees." The cockroaches said, "Oh mighty Queen, how does one do that?" She replied angrily, "I set the policy -- it is up to you to work out the details."

Now, we are faced with a little bit of that. We cockroaches in the universities are being asked to work on details that many times we don't have the wherewithall to work on. I am going to tell you more about that because it is one of the hazard research criticalities that really is the subject of my conversation with you this morning, but as I talk about this, I am going to try to keep all of what I am saying on a low tone because I think that we are dealing with fundamentals rather than with scientific principles at this stage of our game and I am worried about how I might say what I am going to say. Often what we say takes on a different coloration. I don't mean to be offensive or overly strong in what I am going to say, but I am going to say first that with respect to our being cockroaches, let me tell you that universities cannot think great thoughts when they are fighting for their lives and this is one of our problems today.

Although research probably cannot solve completely the

DR. JOHN GRIMALDI WITH DR. MICHAEL J. RABINS, MR. WILLIAM BURNS,
AND MR. JAMES FOLEY.

hazard control enigma, its principles are the best we know for making reliable progress toward the solution. And universities should be major centers for performing the necessary work. However, what is expected of the university often exceeds its resources. When discussing safety research, particularly with respect to the university's role, a primary consideration should be the need to maintain the university as a resource.

Simply depending on the university to reply to RFP's as a means of stimulating the wanted research is not good enough. Proposal preparation is expensive. Most universities, it seems, cannot afford to respond to all of the RFP's within their area of competence. And when they do reply, their chances of winning the award often are insignificantly small. An important safety research need, therefore, is to sustain the university's capability as a resource center. Otherwise, the full value of the university's safety research potential is not apt to be realized.

Ms. Connor very clearly said that policy making is one of the great problems in safety and hazard research work of any kind. Certainly this is true. We know that there are no bad decisions at any time. There is just bad information. Given the correct information, any policy maker is going to come to the right conclusions. The trouble is, however, that not only is it a matter of developing accurate information, gentlemen from the agencies, but it is also a matter of developing information in such a way that it is going to be persuasive, because accuracy alone is not the answer. We have many, many times developed some very good, effective, positive, strong, clearly-presented information, that will tend to bend certain attitudes with respect to safety. Yet none of these has really come forth in any demonstrable way as a policy. The reason is that often we who are communicating this information don't seem to be able to communicate it on a broadcast wavelength that is tuned in to what the executives who are running agencies are using as their receiver wavelength.

Now, maybe we have to know more how to do this kind of communication. It is certainly a part of the behavior modification problem that has been talked about this morning. We do know that there has been a great deal of money spent on means for behavior modification that has been criticized vigorously in the safety community and outside of it by professional people as well as dilettantes who have taken an interest in safety. The public advocate group especially, I think, can be singled out this way. The point being that so much money has been spent, for example, on driver education, and no demonstrable results have come from that, clearly a proper argument. On the other hand there is no demonstrable results that driver education has not proven effective.

The point is, however, that we don't know how to communicate, which is all education is, in such a way that we are able to persuade the actions that education is supposed to be teaching us to follow.

My own work in safety came about because I was an apprentice aeronautical engineer at Grumman some years ago and I became concerned with a human practice problem in the cockpit design. The important thing about this story is that the Navy said, "We won't make this change in the design of the airplane because too many pilots have been taught to use this particular configuration in the cockpit and it will mean a whole re-education process that we don't want to go into. What we will do, however, is teach the pilots what the mistake was in the behavior patterns that were involved in the five crashes out of 25 Grumman airplanes

that we distributed to the Navy as prototypes and then, through re-education, get the pilots not to make the mistakes that they were making.

I don't know whether or not the re-education process was successful. I have a strong feeling it was not, because I do know that, among other things, we do not know how to educate so well that we can motivate people to perform as we want them to perform every time. We just don't know enough about this in education. This is one of the great weaknesses of education.

Assistant Secretary Connor's keynote address also noted that policy-making requires the best of information. In safety this has not always been readily available. One trouble is that the knowledge at hand often is influenced by the hazard approach that is fashionable at the time. We spend a great deal of our time with the conventions; orthodoxy is the great deficiency in the whole area of safety research.

Until the late 1960's it was widely believed that safety is an individual responsibility. Its sensible goodness and the fact that usually some human failing is the initiator of most harmful occurrences convinced almost everyone, it seems, that safety essentially is a moral problem. Safety research fell into line and generally attacked hazards as if they could best be overcome by learning more about how to increase safety consciousness. Safety's protagonists did not ignore the need for upgrading physical conditions. Highway and motor vehicle improvements were notable. But safety achievement clearly seemed directed toward finding and applying ways which would stimulate constant personal attention to using correct (safe) methods, thereby assuring the prevention of "accidents."

By and large, the drive for safety achievement at present is harnessed to the prospect that engineering can overcome the fulfillment difficulties that are inherent in safety consciousness approaches. Haddon, Moynihan, O'Connell, and others wrote distrusting opinions of behavior modification techniques. They posit that the problem of reducing "accident" rates is demonstrably one for engineers.

Although it is quite true that the investigation of technological systems at times can furnish procedures which have the utmost potential for controlling hazards reliably, this occurs only where engineering revisions can eliminate physical hazards or modify the injurious potential to an appropriate tolerance level and where operator errors that might destroy the system's safeness can be overcome by the engineering designs. This rarely is possible, however. Therefore, the capability of research to uncover absolute answers to safety problems generally must be regarded with reservation.

In this light, it may be seen that policy-makers indeed are on the horns of a dilemma when it comes to deciding which direction they should take in order to advance the reduction of "accidents."

The necessity for having information that accurately describes the elements of a policy-making problem literally can not be met under the current "accident" rubric. The term frequently is interchanged with "injury," although it should be evident, if Webster's definition, "an event occurring by chance or from unknown causes," is considered, that much synonimity can not be assumed.

We must remember that anything we call an accident, of course, as I am sure most of you know, is a wholly improper label for these kinds of events. Only about five to 10 percent, in my calculations, of the events that we are dealing with are truly accidents. Most of them are predictable occurrences and so, by definition, should not be called accidents. But, the whole sequence that occurs has to occur in almost a pre-determined way. It is like putting the key into the lock. Unless the key can move the tumblers in the right order, the lock doesn't open and unless the sequence of events occurs in any particular system that we are dealing with, the unwanted occurrence that we are fighting so hard to prevent, will not happen either.

An "accident" need not have an injurious consequence, nor need an injury be caused by an accident. More important to the researcher who wishes to establish accountability for a harmful occurrence, a true accident (according to the definition) is not preventable. Only those cases where injurious causes are known, suitable controls are available, and which should have been applied are capable of being called "preventable."

Data that are not clearly descriptive lead to obscure and inaccurate observations. This, it seems, has been a major handicap for effective hazard control research. Its effect often may mislead policy makers gravely.

Due to many reasons, but probably because the hazard causation phenomenon is not yet fully understood, researchers often attack the control problem as if it can be solved either by correcting the harmful acts of people or re-engineering physical conditions.

Many safety advocates prefer to concentrate on eradicating harmful conditions. The intention is reasonable since the elimination of harmful agents indeed prevents the injury they can cause, irrespective of behavioral inadequacies. However, in most instances the best that can be done is to blunt the effect of the agent of injury. The current preference for safety engineering approaches has de-emphasized behavior-related investigations. Although there is no acceptable research that supports the use of behavior modification safety approaches, there is none that rejects it. The question is moot, particularly with respect to driver education, which has been the most extensive attempt to modify operator behavior to date.

At one time, human errors were considered the most important problem for safety. The rationale in this case also is clear. It called for the elimination of unsafe practices under the assumption that people, when correctly instructed, would not commit the errors associated with "accidental" occurrences.

The dichotomy would not be troublesome if it did not polarize the view of safety. The impression it creates is that safety is achievable either by engineering or behavioral strategies. Consideration occasionally is given to blending both -- as it should be -- but in general one tactic or the other prevails. Frequently lost as a result is the fact that harmful events are the product of many interacting causes. Therefore, neither strategy alone may be effective.

There has been no lack of inquisitiveness about "accidents," particularly concerning their occurrence on the highway. Safety researchers have been devoted to answering questions about the incidence, distribution and agents of the injuries that have emerged from motor vehicle driver and industrial worker populations. The investigators have been interested also in the

mechanisms by which injuries occur. However, the level of causal analysis usually does not go beyond the identification of the immediate injury-producing factor in the environment. A woeful lack, it seems, is the absence of information about interactions which often precede injurious events or add to their seriousness.

The aim of most safety research parallels the epidemiologist's. It studies the incidence and distribution of injuries in a population and attempts to find controls. If the countermeasures do not require that individuals participate voluntarily, so much the better.

Safety is not achieved simply by regulating agents of injury, however. The process involves many factors which, unless understood and controlled, trigger the harmful occurrences. This is a reason, perhaps, why epidemiological methods do not as yet seem to be leading to the wanted solutions.

Where injuries occur in similar settings, epidemiological investigations may provide practical remedies. However, most injuries do not occur in homogeneous surroundings. One of the great dilemmas of safety research, in fact, has been to find enough factors sufficiently common to enough hazardous situations that would furnish specific remedies for the prevention of significant numbers of injuries.

It is probable that much of safety's early gains are attributable to the relative ease with which significant numbers of corrections once could be achieved. More recently, however, it has been necessary to deal with the knottier problems that underlie the causes of harm.

Inherent in the hazard control problem are indirect contributors to the occurrence of harmful events. Their presence and the extent of their culpability often may not be clearly seen, which may explain why simplistic safety approaches endure.

The direct and indirect causes of harm seem to fit three categories:

I. Hazards: (i.e., uncontrolled forms of physical energy and the human deficiencies which are the source of harmful events).

II. Interactants: (i.e., economic, political and technological restraints which obstruct or tend to ameliorate hazard control decisions).

III. Proximal Causes: (i.e., the agent which produced the harm).

In this harmful category I is the direct cause. II is an indirect cause of harmful occurrences. III is directly the result of deficiencies in I and II.

Many times the proximal cause appears to be the hazard. For example, when ordinary glass was used for automobile windshields, it lacerated the car's occupants in a collision. The hazard, however, was the physical and/or human factor(s) which, in the absence of suitable controls, occasioned the collision. The shattered glass is incidental. Any one of a number of other proximal causes (e.g., the steering wheel, dashboard knobs, et cetera) also would be injurious. They did not create the collisions which were responsible for the proximal effect. Therefore,

the hazard is the uncontrolled energy form and human deficiency which, if absent, would not have enabled the collision to occur.

The practice of concentrating on proximal causes often results in overlooking the hazard. A research solution of a sort has been found in systems analysis methods. Although not a scientific approach in the classical sense, they provide a rigorous analytical means for studying the manner in which a systemic failure may occur. When coupled with mathematical models, which express the significance of variables in the system and their interactions, the methods may be suited to testing specific hypotheses about the occurrence of unwanted events.

It is presumed that by studying the hazards, which by definition here involves physical energy forms, as well as socio-physical factors, the product will be facts marshalled well enough to overcome the interactants restraining effects. Optimum safety results then are expected to follow. This is a more subtle, yet more practical, approach than the traditional accident prevention concept.

The hazard identification problem and control problem are not peculiar to transportation. We are talking about intermodal safety research needs and I think this is appropriate. The problem is germane to every issue that threatens people in our dynamic society; the environmental problem, the occupational safety and health problem, the consumer problem, and transportation in all its forms. Unless we begin to think about safety in terms of its entity rather than in terms of the specific areas of interest, we never will get the base down, the foundation down, that will allow those specific systems to perform what they are expected to perform in our days ahead.

The great trouble with all of this is that there is no money to do it. Of all the money that is available, damned little is in safety, but we spend $2 billion on cancer research. With respect to hospital bed-days, almost four times the number of hospital bed-days are spent with trauma patients of all forms than for cancer patients, and slightly more than the number of hospital bed-days that are devoted to heart disease patients, and yet the HEW money for research in our little world is devoted primarily these days in cancer research and heart disease; trauma being the great problem and largely ignored. But, where it is being given some attention, that money is given attention only in specific areas determined by the policy-makers first. We, the cockroaches, are asked to work out the details, and I daresay that we are not going to be as effective as we want to in working out those details under the circumstances.

I will conclude much more quickly than I would like to by saying that we can be as orthodox as the devil in carrying on our responsibilities, as university people or just practitioners, in this world of trying to control the hazards that produce the unwanted occurrences that threaten our society. We can be as orthodox as the devil -- and just as wrong. I think there may be many reasons for people to say that we haven't been as effective as we should be. You know that and that is why you are here.

I have been delighted to have a chance to talk to you in this very important conference.

MR. RABINS: Thank you, John. I am anxious to hear more about some of the comments that you have made, when we have more time in the panels later. In particular, I anticipate discussion on your provocative statement about the predictability of

90 percent of all accidents and your comments about the sequential nature of events leading to accidents.

Our next speaker is with us on borrowed time, so to speak.

He is borrowing time from his duties today as chairman of the National Motor Vehicle Safety Advisory Council, which was established by an act of Congress in 1966. This is a 25-man council that reports to the Secretary of Transportation advising him on motor vehicle safety. That council is meeting today, which is why he came in late and why I presume he will have to leave following his comments. We are sorry about the conflict.

Dr. Campbell is Director of the Highway Safety Research Center and a professor of psychology at the University of North Carolina. He spent seven years at Cornell University and at Cornell Aeronautical Laboratory as head of the accident research branch. Since 1966 he has been Director of the Highway Safety Research Center at North Carolina. Dr. Campbell:

DR. CAMPBELL: My topic is the highway side of these various modes and the consideration of safety. The nature of the analysis problem in the study of highway crashes and the study of counter-measures can be illustrated by the 55-mile an hour speed limit and the great reduction had in fatalities during the last year or so.

There have been many studies done in an attempt to parcel out the various factors that may have contributed to the considerable whole-number reduction in highway deaths recently.

The fact that numerous people have said various things about what caused it tells you something about the analysis problems: there is a great difficulty in deciding which of several factors were present during the period in which the deaths went down so sharply. Simultaneously there were the consequences of the fuel shortage (fewer miles driven), and perhaps an even more important, subtle change in the nature of trip selection and trip characteristics. There were the reduced speeds. There was the recession. In every recession since the big one in 1930, there has been a drop in the death rate. I guess that is about the only good thing that goes with a recession -- a drop in the highway death rate. There was also the continuing infusion into the vehicle fleet of the more modern cars which are associated with a demonstrably lowered death rate due to many factors, including the increased use of restraint systems.

In some fashion, these several factors interacted to produce a dramatic drop in the death rate, which has been gradually declining for 50 years. This drop was so large that the whole number of fatalities actually went down, even though the size of the population continued to grow.

I submit that this illustrates some of the characteristics of working in this area, that there are a good many factors simultaneously operating, some cancelling other ones and some compounding them. Any one factor characteristically has only a very low order contingency with the end result of crashes or some measure of the dependent variable. Also, there is the problem that the several causal factors, which have this weak contingency with the dependent variable, are themselves not orthogonal to one another. They are, in fact, correlated among themselves in some complex way. This immediately sets up some of the limits and some of the requirements in terms of the methods that can be used to study the problem.

I think it might be fair to say that, during the first 40 years after the automobile had become a noticeable safety problem for our society (by the late twenties we were already killing over 30,000 people), more attention was given to the human factor than any other aspect of the problem. This extreme emphasis on the driver was the result of incontestable statements that nearly all crashes can be variously attributed to the operator (on the order of 85 percent). A whole body of literature was developed to find out what kind of characteristics, or predictive factors, would differentiate persons destined to have accidents from those who seem to stay free of them. As many as 400 of these driver-oriented studies were done at that time.

In trying to assess this literature, you can conclude that just about anything that you can think of that is relevant to an accident, from bad family to bad politics, can enhance or raise the risk of a crash, but always at a very low level of predictive power. Because the predictive equation is such that the predictors might account for somewhere between two percent and nine percent of the variance in the future accidents, the search for the accident-prone driver has been largely unsuccessful. The predictive power is simply too weak. And, of course, another reason is that the characteristics of the accidents do not correlate well with themselves in different periods of time.

This, as well as many other factors, has led, over the last 20 years, to research priorities being shifted away from the driver and toward the hardware or non-personal side of the problem. This has happened to such an extent that many people who are just now entering this field think, "Shouldn't we be focusing on the driver?" In response to their puzzlement, I can only say that none of us has forgotten about the driver, and that, in fact, one whole generation of research has been devoted to that particular emphasis.

In the future, we are going to be looking at an environment that can have at least some predictable changes. We are going to be faced with a more urbanized society, an increase in limited access facilities as the Interstate System is completed, and more small cars in the vehicle population. Furthermore, the average age of the population is going to increase somewhat in the next decade as the birthrate falls. We are going to see changes in the distribution of drivers by sex as more women interact in life in such a way that they do more driving and become more frequent victims of highway crashes. All these changes are going to alter the accident environment and should have some bearing on the kinds of automobile or highway crash problems that might be examined by our research efforts.

One of the problems is the crashworthiness of small cars. As has been mentioned, fuel considerations are in the process of dictating a change in car size. Unless something drastic intervenes, the energy gains that may be achieved through this will be offset by injury and death losses as smaller cars replace larger ones in the vehicle population. Unless vigorous and effective attention is devoted to this problem, we will not be able to hold the line on motor vehicle deaths as this changeover occurs. The problem will still exist even when the vehicle population is predominantly small cars: when two small cars collide, the injury risk to the occupants is considerably worse than it is when two large cars collide. Consequently, this problem is a long-term one that will not be alleviated when the changeover to smaller cars is completed and crashes involving large cars striking small ones have become less frequent.

Even more important than the effects of the changeover to smaller cars is the ability to restrain vehicle occupants. I believe that this is the single most critical issue facing us now, and that it will continue to be critical for the next several years. There is a great deal of research that has gone into occupant restraint systems, but within the next decade we are going to have to convert the findings of this research into actual increases in occupant protection. Our current essentially unrestrained motoring public must be converted into safely restrained motor vehicle occupants. If mandatory seat belt usage is the only way this can be achieved, then that is what we must do. Personally, I hope that that extreme measure will not be necessary, and that we can protect vehicle occupants with a combination of various kinds of passive restraint devices.

When vehicle occupants are effectively protected with restraint systems, possibilities in vehicle design will be opened up that are not present now. Some of the design priorities will be changed because there will be more predictable trajectories for the occupants of crash-involved vehicles. The changes in safe vehicles design can be considered a mopping up action (i.e., after effective occupant restraint is achieved, the impact may be so pivotal that a full decade of design modifications may be required to completely optimize the safety within the vehicle).

If all this does happen, then perhaps there will be a long-term shift in research priorities that will bring our emphasis back again to the driver, in terms of safety gains in the future. (Because of time constraints, I must exclude the roadway element in this discussion.) Although I do not know at what place we will see the asymptotic characteristic of the death rate, I do suppose that it is going to level off to some irreducible minimum at some point. At that point, further safety gains may be possible only through additional driver-oriented research. Nevertheless, I do not believe that this is possible to achieve through increased efforts to improve predictions of who is going to have an accident and through subsequent intervention at some point ahead of that predicted time.

If you are interested in that literature, the best recent study and a comprehensive review of the literature is in the March, 1975 issue of the Journal of Safety Research. Incidentally, breaking into the literature in this field is not easy because there is no orderly set of publications as there is in other academic disciplines. Universities or researchers who are interested in entering this field for the first time would be well advised to do the necessary but difficult work involved in a comprehensive review of the literature.

As you know from having seen papers from your own graduate students, it is obvious when someone is not familiar with the key items in the research literature, and this can be a big factor in the way a proposal is received.

I do not believe that we should pursue attempts to identify accident-prone drivers and then take extreme measures to remove them from the driving population. Instead, emphasis should be placed on evaluating counter-measure programs as they are being formulated. More highway safety money is currently spent by the states for programs designed to do something with or for the driver than for any other single aspect of highway safety, with the possible exception of the actual building of highways. The experimental method for evaluating these programs is nothing more than the difficult task of trying to introduce a reasonably rigorous experimental design into a societal program, of actually

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setting up the necessary control groups, and of introducing programs or pilot testing them so that they conform to the criteria for reasonably rigorous experimental design.

The criteria must be rigorous because the probable benefit of the program is very modest. However, even if the impact of the program is small, it can still more or less break even on a cost basis. The analyst or researcher, nevertheless, has the methodological problem (or the experimental design problem) of detecting even this modest effect. The sampling techniques, the experimental design, and the analytical approaches that can indicate the extent of actual benefit in experimental programs are difficult to develop and deserve a considerable amount of our attention.

I believe that we are a long way from having solved the problem of crashes on the highway. Nevertheless, we may be closer than we realize to the point at which appreciable gains are very, very difficult to come by. It may be that with current roadside hazard removal programs, and with the achievement of occupant restraint, we may, perhaps in the next 15 years, be reaching the point beyond which future gains will be very difficult and very expensive to achieve. At that time, it is going to require a great deal of ingenuity to continue to make highway safety gains. I believe that we must begin now to look ahead in anticipation of that time.

Thank you very much.

MR. RABINS: Thank you, Dr. Campbell. I hope we don't get to the point where we lock up all the people who are potential accident hazards, because at one time or another I suspect all of us would be in the "clink" for some time. It is like Pogo's classic comic strip: "I have met the enemy and he is us."

Our next speaker is going to talk on the subject of Systems Safety Methodology. Professor Pignataro has been with the Polytechnic Institute of Brooklyn, now Polytechnic Institute of New York, since 1951 and currently he is the head of the Department of Transportation Planning and Engineering at the Polytechnic Institute of New York. Dr. Pignataro is currently under contract with the Department of Transportation, working on the subject of his address.

MR. PIGNATARO: Thank you, Mike.

My subject is transportation safety from a systems viewpoint. The most common and readily observable phenomena regarding transportation safety is the multitude of solutions available.

Safety experts everywhere agree on the complexity of aspects related to transportation safety and offer a multitude of solutions. Some are looking at the operator and the activities influencing his performance, while others look at the methods to minimize accident occurrence and its impact.

Though fragmented in nature, the current methods and approaches to safety in the field of transportation rely heavily upon two basic procedures. One is the preventive considerations in design and the other is the studies of accident experience.

The intensity with which these methods are applied and consequently their effectiveness, varies greatly from mode to mode. Aircraft are designed, tested, and certified with safety

in mind, while automobiles have safety features thrust upon them and rapid transit railcars lack a standardized approach to safety altogether.

The problem of transportation safety encompasses all modes, all classes of population, all economic levels and all transport purposes. In terms of numbers of accidents, deaths, and injuries, the motor vehicle mode predominates; nevertheless, the problem goes beyond motor vehicle statistics. The history of transportation is replete with examples: the periodic tragedies of air crashes involving larger and larger aircraft; subway trains crashing or malfunctioning after many years of neglect and encroaching decrepitude; modern rapid transit vehicles being delivered with serious errors and faults in design. These present a great need for a systematic methodology and its application, rather than reliance upon traditional approaches, which have not provided the answers sought by the industry.

Recently, methods developed for NASA space probes and for military purposes by the U.S. Department of Defense, revolving around the concept of system safety, are being studied to provide an answer to safety problems plaguing the transportation industry.

The present inter-disciplinary efforts undertaken at the Polytechnic represent one of the first major projects to adapt and tailor existing systems safety methodology to the needs of the transportation industry.

There are three phases that were proposed under this study. The first phase deals with the identification and resolution of key issues and preparation of a draft methodology for the study of transportation systems safety for all modes. The second phase deals with the application of the methodology as developed and this involves the selection, execution, and reporting of case studies. The third and final phase deals with the refinement of the methodology, generalization of guidelines and further testing, if necessary.

During the first year of the study, we are devoting our efforts to the following:

o review of techniques and methods related to systems safety for applicability to transportation safety,

o the review of existing safety procedures employed in the transportation industry and their validity,

o the establishment of key issues to be further investigated and incorporated into the final methodology, and

o the adaptation of NASA-DOD systms safety procedures and their development into an overall methodology applicable to all modes.

Through the years, system analysis techniques have been devised and used to maximize systems design and operating objectives. Their intent has been to enable decision-makers to reach correct conclusions, using an orderly process of data collection, analysis, modeling, management, and evaluation.

As the system analysis discipline has developed, distinct subclasses such as control, communication, reliability, and safety analysis have appeared. Many of these disciplines, especially safety and reliability, have been encouraged in their

development by DOD and NASA requirements.

Systems safety analysis is a relatively new discipline and its techniques have been used effectively by the military, the aerospace industry, and more recently, by the Atomic Energy Commission on projects where designs, equipment, and procedures were developed without precedents (and therefore without guidance), and where the consequences of failure are extremely serious.

The need to identify, at the earliest stages of design, all possible elements or combinations of causes that might contribute to a failure of the system, led to development of a set of formalized procedures for safety analysis, named system safety. These procedures required a logical examination of all elements of a system and the identification of all possible sources of accidents. The analysis does not end with the identification of hazards, but estimates the probability of their occurrence, and points our available options for their elimination of minimization.

In addition to safety analysis, system safety includes a set of managerial, contractual, manufacturing, testing, and operational procedures. This has proved to be an invaluable managerial tool in improving the decision-making process regarding hazard elimination, hazard control, and risk taking at the earliest stages.

This systematic approach to safety includes conceptual formulation, design, test and evaluation, construction, training, certification, operation, and maintenance.

A transportation project can be divided into several parts based on its evolutionary development. There are five distinct levels attached to a transportation system cycle, the conceptual level, the contractual and preliminary design level, the engineering design level, production or construction level, and, finally, the operational and maintenance level.

This "system life cycle" originated with the military, and has been adapted to the requirements of the transportation industry. In some cases (as with the military), a system may be declared "obsolete" and disposed of. This is included in the system life cycle for transportation, only as a remote possibility. However, we almost came close to that with the Morgantown system.

Systems Safety Methodology is a management tool buttressed in the technical analytical procedures for identifying the probable areas of failure in the system. The methodology is pursued by developing a Program Plan which requires:

o First, defining the system. The system must be defined by its boundaries and the details of its infrastructure.

o Second, setting safety goals and objectives. What level of safety is acceptable? What level of safety is achievable within given constraints and restraints? We have heard a good deal about this during this morning's talks.

o Third, determine organizational structure and responsibilities. Who is responsible for setting the goals? Who is responsible for overall safety of the system?

o Fourth, identify in preliminary fashion, hazards and their controls. Analytical methods such as the failure mode effects analysis or fault tree analysis would be applied here.

o Fifth, define and describe scheduling and review procedures, that is, establish milestones. Regular review processes and procedures must be established.

o Sixth, describe methods for evaluating and monitoring performance. This involves "before and after" studies and specific procedures for noting changes in safety levels.

o Seventh, define data base and documentation requirements and procedures. Where and in what form are data required for the analyses to be made? This was pointed out several times this morning. What document should be prepared for specific reporting procedures?

Analytical techniques are used where applicable and where appropriate, but the overall management approach, properly implemented, should eliminate the hit-or-miss, or fragmented, approach to safety which we have today, which is wasteful of both effort and money.

Through the use of a systematic approach to safety, potential hazards can be identified before they are activated. The thrust of a system safety approach is oriented towards action, rather than reaction. This is one of the main differences beween the classical, conservative approach to safety, and the dynamic system safety approach which we are discussing today. Accidents can be prevented if necessary and adequate action is taken to eliminate and control hazards. A system safety approach does not imply the system must be risk free, but rather, that risk can be controlled and made known to management. Thus, the resources needed to design or redesign a transportation system to meet specific risks can be estimated at the outset and refined as work progresses. Development of data to support managerial decisions may be seen as the real role of system safety.

Thank you.

MR. RABINS: Thank you, Lou. I know that the Department is looking forward to the continued flow of results from your research and we are very anxious to utilize them across all of the modes, so your work fits in very much with the goal of this conference.

Your remark about the AEC systems studies brings to mind the recent cover story in Newsweek about nuclear power plants; a study by, I believe, Professor Rasmussen at M.I.T. on the probability of catastrophe. I believe he came up with a number like one chance in 50 billion of a disaster, if I remember correctly, but that gets back to what you brought up, Dr. Grimaldi, about how do you predict the sequence of events that involve the human being as one link in the sequence, and the unpredictability of the human factor.

Our final speaker is Professor Herold A. Sherman, who is Executive Director of the Institute of Safety and Systems Management at the University of Southern California. He is also President of the Flight Safety Foundation. Dr. Sherman has been trained in business administration and has had long experience with a number of different companies and as a consultant to a number of companies. Since 1963 he has been with the University of Southern California. He has broad service in both academic and community affairs and since 1968 he has been in his current position as Executive Director of the Institute. His topic is a fitting wrap-up for this morning's session. The title is "What To Do with the Alligators."

MR. SHERMAN: Thank you, Mike, Phil, and I will just say, distinguished participants.

I would like to take a liberty, as the Admiral did, and introduce some of my associates that are here today. Unfortunately, I don't have the discipline he has. I see some have already gone. Jerry Fletcher was here. He is the Director of the Traffic Safety Center in the Institute. Jerry is also a professor in the School of Engineering. Jack Baird was here. Jack is a retired Naval aviator, a captain, and has been involved in accident research for many, many years and he is probably one of the authorities on automotive, bus and truck accident evaluation.

We do have Herk Roland. We have just heard about system safety. Herk originally, back in 1965 and '66, worked with Chuck Miller in the development of the original MIL standards for system safety with DOD. He is now our PI on bicycles. He is going to be an authority on bicycles for DOT. Herk, will you stand up, please?

Also, Jack Carroll; Jack, would you stand? Jack has a human factors background, on loan to us from NTSB, and is serving as managing director of the Flight Safety Foundation here in Washington. That is an affiliate of the university, but it is international in the civilian aviation area.

We have been fighting the alligators all morning and I guess draining the swamp more recently. What I thought I would do would be not exactly what I was requested to do, but see what we should do with the alligators. First, I would like to see a show of hands of how many engineers are here, engineers from schools of engineering, engineers by training, technical types. Would you all raise your hand, please?

[There was a show of hands.]

MR. SHERMAN: Thank you. That is just about everyone. I will go on because we need good engineering in safety. The alligators have been pretty well identified by the distinguished speakers from government this morning by the statement of policy of the Secretary. This was handed out to everyone. I think a good place to start and maybe summarize this morning would be the Guidelines* for the Conference Workshop on Inter-modal Safety Research Needs. That document extracted statements of research needs from the statement of a national transportation policy.

I won't take the time to go through appendix II** of the Guidelines now but I think if you look carefully at these you will find that of all of these needs, there may be only one or two that are technical in nature and that the majority of these needs deal with decision-making, policy formulation, and need for better understanding, recognizing, and evaluating consequences of action.

I think that the Office of University Research in the few years it has been operating has done an outstanding job in getting off the ground, but I would like to recommend now that we have a new Secretary and a new statement on research policy and research needs, that maybe some of the effort be devoted and redirected in the next few years.

Those of you who have picked up, or received in the mail, a yellow book*** on the awards to academic institutions by

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* The Guidelines are included as appendix I to this report.

** A list of research needs identified in the National Transportation Policy Statement. They are extracted and included as appendix II to appendix I of this report.

*** DOT-TST-76-37, Awards to Academic Institutions by the Department of Transportation in FY 1975.

DOT in 1975 may have noted that there are very few awards that are behavioral or managerial in context. If we take a look, for example, at the Federal Railway Administration presentation on roadbeds, all of the university research is directed in technical areas, but we continue to hear about the problems with human factors.

So, I would recommend, first, that the efforts of the university research, not necessarily in the modes, but in the university research, consider some redirection and efforts to the needs that have been talked about today, other than technological. Maybe even half should be redirected, without restricting the seed money that is going to universities on technical topics that have a potential pay-out.

Secondly, I would recommend that the Office of University Research and DOT recognize that most of the needs you have been talking about have two characteristics. First, they are behavioral; they involve attitudes, motivation, and human factors. Second, they require managerial decision-making; they are statements of policy and data information accumulation. I did see one good example of the inclusion of human factors in the NTSB revision of their ground safety and automotive investigation form which will have a sizable human factors block in it for the first time.

I asked if there were many engineers present. We did get a large show of hands. We do find that safety somehow is very closely related to engineering because of the technological nature of the subject, but the problems that we need to address frequently are not engineering or technological problems. They are people problems and this is the thing that I would stress.

The 55-mile an hour speed limit was a good example of where we could, with legal enforcement of a speed limit, contribute to some degree to a great reduction in loss of lives under the cause of energy, but we could not accomplish that with seat belts, with mechanical means, and with a sizable expenditure.

So I think that with the alligators, what we really need to do is to take charge of them and try and tame them and change their behavior and their attitudes. We are not going to accomplish this unless we provide management and that means planning, information and data control, and monitoring. These are the things that you have been talking about today.

Now, John Grimaldi mentioned the amount of money that is spent on cancer research. We are all familiar with the amount of dollars that go into research in other departments in government. I would like to just look within DOT from my own perspective, and the dollars add up to about 22 million dollars spent by the agencies for university research. The major agencies that are funding universities are the Office of the Secretary, University Research, NHTSA, and Federal Highway. Now it is interesting that these three administrations or offices have the smallest DOT budget; Federal Highway with $54 million, NHTSA with $39 million. They are the major contributors to university research. So, another recommendation I would make would be at the macro level. If we are really serious about saving lives in automobiles, we want to recognize the dollars that these agencies really have to have to do the job.

One of the problems universities have is that the government likes to do things for themselves. The FAA is a good example. The FAA spends $3.8 million with universities. $800,000

of that, plus, is for a training program with a university, so they spend $3 million from a budget approaching $1.5 billion.

The in-house research that goes on in FAA is probably 25 to 100 times what is contracted out to universities. I think that might be something that someone could look at. I am not sure it will change, but a research agency has been developed in that organization with a sizable, with a great amount of, funding. I think there are a lot of reasons it could be done outside and maybe should be done outside.

What else can we do with the alligators? One thing we can do, and this has been touched on earlier, is to develop social and economic models. This doesn't necessarily have to be done in schools of engineering or by engineers, because we have mathematical and computer simulation in many, many other areas,

Another effort would be to apply some different methodology that is existing. We heard this morning about hazardous materials. We had a modest contract for hazardous materials with Mr. Burns here to start something off on modeling transporting of hazardous materials. I wish we knew there had been a million dollars available for that. There is a technique to be applied. The technique has a lot of potential, but the reason I am mentioning it in terms of methodology is because of one part of it that I am leading into. In the little study we did, and Herk Roland was part of that, we had one of our attorneys use the delphi technique for establishing the cost of the loss of life. This is one of the hang-ups we had in this program for a while, how do you determine the value of a cost of life? Using a delphi technique in panels of trial judges and trial attorneys around the country we did come up with a value that could be plugged in which was better than anything else we could hang our hat on.

I will close with a beautiful case study, if I might.

In 1970 the clean air standards, the federal bill, was passed. In California, we have an anti-smog law which we have had for several years. (It means that we get a couple of miles per gallon less than a driver in the rest of the country, but it is a program that has worked.) In 1973 with EPA, there was some sort of a communication to southern California to control the transportation. On the 15th of March this year the number one lane in the Santa Monica Freeway was closed in both direction for a period of time in the morning and the afternoon, from 6:00 to 10:00 AM to 3:00 to 7:00 PM. The Santa Monica Freeway is 12.6 miles long and that lane was reserved for buses or car pools with three or more people.

This might have been a good trial balloon and it might be a good way to test something, but it just happens that the Santa Monica Freeway is the most heavily trafficked freeway in the world. It carries 250,000 cars per "4-hour" period. There have been some problems. It didn't get much press back here, but the overall traffic is down, between 15 and 25 percent. The cars went off on the peripheral streets and the arterial streets. The accidents on the freeway -- with the reduced number of cars -- are running at a rate about four times what they were before. The time required to travel this 12.6 miles is equal to what it required with all of the prior lanes open for traffic flow, but it does not include the waiting time on the metered ramps now, which is 12 to 18 minutes average, depending on the location of the ramp.

What has happened in the City of Los Angeles now is all of our traffic lights are out of timing and out of sync and our accident rate in the peripheral area of the Santa Monica Freeway has gone up six to seven times in the same period.

Caltrans is now taking some action. First, they have changed the meters and changed the timing, fine-tuning they call it. Secondly, they have changed some barriers so people don't have access at certain locations. More important, they did get some additional money from the federal government to improve their marketing program to have this accepted by the public.

There are some lessons I think we can learn from this and this is why I am closing with this case study.

First, the American public did go to small cars when there was an energy crisis. For example, about 1/2 of all of the Porsche's, Mercedes coupes, Datsun Z200's, TR's, Hondas, in the whole United States, are in southern California and they just carry two people. The number one seller in California last year was the Datsun, the number one seller of the year before was the Toyota; all small cars, most of them two-place. So, we immediately have a problem because we have cars that don't carry three people. We also have a pretty good high population of motorcycles. Mike could probably tell you what that is but I am sure it is much higher than the rest of the nation. So, they are still using the Santa Monica Freeway.

Second, here is what happened, if you didn't get the news back here. Well, I don't have to tell many of you about the California public. The first day people had cans of nails and bags of nails and they were throwing them in that lane so nobody could use it. Then it cooled off a little bit and they gave a few tickets and then everybody started to boycott the freeways. Now drivers have come up with a better technique, and this is why not many people are using the number one lane. If you finally get through the metered light and you get on the freeway, you are in the five or six lane, which is the slow lane. The cars won't let your car pool get over to the fast lane. They keep you boxed over in the slow lane. If you do, in that 12-1/2 miles, manage to get over to that fast lane, then you have to worry about getting off the damned thing, and they won't let you off. As a result, you have got four or five lanes filled with cars and one lane with a few.

Third, I mentioned the decrease in vehicles. Buses are transporting about 1,500 more people a day. There are estimated about 1,200 more people a day in the car pools. In the process we have kind of screwed up a 250,000 day-car freeway.

In conclusion, this may have been an engineering solution, but it doesn't make good sense as a manager to kick something off and try a trial balloon on the biggest freeway in the world.

Thank you very much, Mike.

MR. RABINS: Thank you, Dr. Sherman. Your comments were particularly timely, Herold, because the advice you gave on redirection of the university research efforts is exactly the reason for this conference and helps to set the stage for the panel sessions. We wish to work with the operating administrations, representatives of the universities and the user community to establish exactly what priorities should be announced to the universities when we solicit proposals next fall.

We have earmarked approximately $5 million for universities this year and we are hoping for the same amount next year through a combination of the University Research Training Program in UMTA, and the Office of University Research in the Office of the Secretary. I don't know the precise numbers of safety proposals received lately in UMTA, but we have looked at the numbers of proposals that we have received in the Office of the Secretary. It totals about 300 per year, and only a very few of them are in the safety areas. That is one of the reasons that we are holding this conference, to try and identify the needs for proposals to come into our program in the safety area, and also to direct them and focus those proposals on needful and relevant areas.

MR. BOLGER: One point before concluding this session. Dr. Hoshovsky has the TRISNET system outside for demonstration. It is right in the next room and he would be happy to show it to you throughout the next hour.

DEMONSTRATION OF TRISNET

"FROM MODAL PROBLEMS TO DEPARTMENTAL DECISIONS"

Philip Bolger
Director, Office of Safety Affairs
Office of Environment, Safety and Consumer Affairs

No decision of the Department of Transportation can be made without consideration of its impact on the safety of passengers, the exposed public, and the transportation system employees. How this is done -- and how effectively -- defines the performance of the safety system. I would like to open this session by reading the basic DOT safety policy, the policy issued by the Secretary in his statement of national transportation policy:

> "It is the policy of the Department of Transportation to provide the highest practical level of safety for people, property, and the environment associated with or exposed to the nation's transportation systems."

As you see, we are talking about the total spectrum of involvement with the nation's transportation systems. I continue:

> "The Department of Transportation recognizes safety as a primary management responsibility. The line manager, the administrator, is the ultimate man responsible, and is a major factor in its decision-making process."

Today we have talked about data, and the need for it in decision making, and it comes right to this point. Again quoting:

> "Its safety programs will stress accident prevention as opposed to reaction, through identification, reduction, and control of hazards, and will emphasize integrated efforts directed at preventing, reducing and controlling accidents caused by human, equipment, or operational factors."

These words are worth thinking about because they cover the spectrum of the activities and the total scope of the transportation system as we discussed it this morning.

The problem of transportation safety is made complex by the sheer size of the transportation system, the diversity of the industries involved, the number of people who depend on its efficiency (as opposed to its safety), and the competitive importance of the national safety programs in a highly competitive industry.

The problem is made more difficult by the changing nature of the transportation industry. Each change in technology creates new problems of safety assurance; each change of social patterns creates different risk factors; each change of industry or population grouping places new burdens on the transportation system, shifts the patterns of use, or alters the economic viability of firms in the transportation industry. In addition, each change of social priorities, as Ms. Conners pointed out, with regard to pollution, or noise abatement, places new burdens on an industry or affects a transportation element in a way that changes its safety level.

The Department, in organizing itself to meet its challenges and to fulfill its responsibilities as defined in the DOT safety policy, is structured in a manner that emphasizes modal correlation: the FAA deals with the aircraft industry, NHSTA with the automobile industry, and the FRA with the railroad industry. This is neither good nor bad as all students of organization and

management are aware, but it does have implications for the manner of problem awareness and consideration. For one thing, it means that the "early warning system" is set to discover problems within a specific mode of transport. The industry concerned, or the public involved, direct their perceived problem through a modal hierarchy. As a result, by the time the problems reach the Departmental level they are imbedded in solutions which are specifically oriented to resolve a modal problem. This sometimes obscures the broad nature of the problem and the multi-modal applicability of the solution. One of the primary advantages of conferences such as this is that it helps us to "break out of the box." Even good ideas, once confined within a given modal environment, have difficulty in being accepted by other modes. We often find that common problems are hidden behind different terminology and that technology transfer among modes takes far longer than is necessary.

The University Research Program was designed, in part, to broaden the Department's view, to let us benefit from a non-modal research orientation; to enable us to step back and view transportation problems as system problems. This can stimulate cross fertilization, highlight areas of high modal transference, and be of key assistance in analyzing interface issues with a safety policy implication. Certainly this is true for the Secretary and his staff. They must look across the board. That is really what we are talking to you about and why we are asking you to help us.

The interface problems are very real ones. Let me mention several examples.

-- A reference was made this morning to a case where UMTA was handing out money and the FRA and NHSTA were regulating transit vehicles and operations. Here we have three different administrations working in the same area at once. The opportunity for conflicts in safety goals are apparent. This kind of problem relates to one of our panel areas, Problems in Institutional Barriers to Safety.

-- Occupational health and safety is another interface area. It was discussed by Dr. Grimaldi today. We are trying to resolve, across institutional lines in DOT and the Department of Labor, who is responsible. The problem: "Where are we responsible for the safety of employees within the transportation industry, and where does our responsibility end and the Department of Labor's responsibility take over?"

Many other examples could be cited. We need an approach to the problem from the total system standpoint. If we don't, many of the solutions that would be the most feasible, or the most economical, or the most practical, may escape us. We will continue to be down there with the alligators, patching one solution on top of another; fighting one alligator at a time.

The Department expects that the modal administrations will stay on top of the technology relating to its field; highway concrette hardening, rail technology, radar capability, et cetera. But these are not the problems we wish to review today. Let us examine this issue in some detail.

We need technology to provide us with policy options. Technology can shift burdensome, complex, and potentially dangerous acts from man to a machine component. Transportation

vehicles provide mobility, but they must also protect man from the very power he now controls.

We also need human systems which permit man to accept and to adapt these machines to his social purposes. We need software which help man to see the impact of new technology, to train him in its proper use, and to relieve him of fears that the machinery will make man obsolete and incompetent in a dangerous world of machines.

Each safety problem must be recognized as a "system" problem involving both technology or "hardware" solutions and social change or "software" solutions. To what breadth must we examine the problem to determine whether or not a solution is technically feasible, socially desirable, and economically attainable? Thus, a given problem may be solved by hardware solutions such as component redesign, vehicle modification, or control mecchanisms. It might also be solved by software changes such as changes in operating conditions, retraining of operators, modification of vehicle use, regulatory prohibition of the vehicle types as a means of transport, or mandating a decrease in traffic on the mode in question.

Several of the administration speakers this morning have talked about hardware problems since they are very real problems when viewed from the modal perspective. However, a good number of the major problems in decision making in the Office of the Secretary deal with software matters such as cost benefit analysis, cost effectiveness analysis, and economic and social consequence analysis. We are caught up in this. The regulatory reform activity requires that we prove the need for each regulation. It has to be something that the public is accepting or we end up with another ignition interlock fiasco on our hands.

Looking at our problems, and the balance of "hardware-software," I believe that we now have more technology than we can cope with. I do not mean that we should not have more and better technology, only that without a concurrent mechanism to assess the technology, to relate its social and economic impacts, and to provide a system which permits safe use of the gifts of technology, we are unable to use these gifts and the result is controversy and inefficiency.

A prime example is the automobile. A gift of technology we cannot do without, but it is one of the greatest killers of our time. The accident toll is truly incalculable despite many research programs to pin down these costs. We are unwilling to accept the toll as a cost of our society but we are incapable of defining the costs of change. Here, for example, are several problem areas:

o Rigid enforcement of speed and drinking controls.	Can we do this? Technically perhaps we could; socially, very doubtful. Does the American public really want the laws enforced? The technology to measure all speeds is well in hand.
o Make vehicles more crashworthy.	At what cost? Who would pay? What impact on motor carriers?

o Automate roadways to prevent collisions.	Again, at what cost? Who pays? At what rate could this be done?
o Modify driver license controls to prevent marginal drivers from having licenses.	Is there a correlation between test and accident? Would this action be socially acceptable? Would it be enforceable?
o Modify land uses to make vehicle travel less necessary and mass transit more practical and economical.	How can we force population density? Reduced home-to-work distances? Who pays? Would the public agree? What is effect on economy of nation?

University research efforts have been active in many program efforts, such as those indicated above. But we need to view these programmatic efforts in a broader context. We want the universities to accept other roles. One such role would be to develop models which encompass the social and economic implications of each safety program. Another would be to develop methodologies which would convincingly demonstrate the implications of such programs, while still another would be to develop strategies for involving citizens in such a way that a technically desirable program would become socially acceptable.

A review of the work on priorities in transportation safety confirms the fact that it is not new hardware that is sought, but new methods of reaching the human element, or new ways of involving human beings in a cooperative effort to enhance their own safety. Questions relating to acceptance of risk, non-compliance with rules and regulations, carelessness in the face of known risks are important intermodal elements of today's accidents.

The representatives from the modes who spoke this morning were candid and forthright in expressing their views of needs and of failures of university research programs to be responsive to their needs. A common and oft-told story is of the drunk who was searching under the lamppost for his keys. When asked by a policeman where he lost the keys, the drunk waved his arm and said, "Over there, across the street." When the policeman asked why he was looking here, the drunk replied, "It is too dark to see them over there." Research, in a more refined way, has often been accused of redefining the problem from one the administrator wants solved to one that fits the techniques known to the researcher, and then coming up with a brilliant solution for a problem that does not exist or does not have adequate priority to be funded. We would like this conference to close the gap between the mission-oriented problem and the research-oriented solution.

Let us start by looking at the problems. The Statement of National Transportation Policy issued by Secretary Coleman in September of 1975 was a thoroughly-staffed document of the Department of Transportation. Without specifically establishing a section called "Safety Research Needs," the document deals at length with those issues which the Secretary felt had gaps between problem and solution. Most of those dealing with safety were extracted and can be found in appendix II to the Guidelines* for this conferences. We took these statements of need and examined them for inter-modal commonalities. We found that they fell into three broad groups:

* Appendix I of this report.

Group 1 consisted of statements relating problems to their institutional background. "How can we best implement a program in terms of Federal, State or local roles?" "What is the impact of a given safety program on the industry being regulated?" "Have program implementations been helped or hindered by public acceptance?" These issues in general relate to the institutional barriers to safety programs. Solutions do not require new hardware but new administrative techniques and new channels of communication and cooperation.

Group 2 encompass all those issues involved in the process of goal definition. Educational theory deals with the requirement to enlist the interest of the student prior to embarking on a learning process; management theorists describe participatory management and describe the "Hawthorne effect" as aspects of productivity. We need comparable work relating to standards of safety and willingness to take risks. Would people recognize hazardous conditions and work to uphold higher standards of safety if the process by which safety standards are reached were changed? Is there a means of reducing the public's willingness to take risks which involves a different process of standards development?

Group 3 involve internal departmental decision-making. The Secretary expressed a need for a better information collection system, development of new tools for analysis of data, and the creation of an evaluation system which would improve decision-making in the Department. Lastly he expressed a need for an improved departmental management system which integrated these considerations, improved technology transfer from one mode to another, and enabled the Department and the Administrations within the Department to better analyze data and relate data to safety problems and options for safety program improvements.

Each type of solution has a required timeframe for its implementation. Whenever a standard is established a question always arises as to retrofitting existing vehicles. One of the reasons that it is difficult to change the casualty rates through making changes in vehicles standards is the slow movement of vehicles equipped to the standard into the marketplace. The improvements from a variety of actions and standard changes are coexisting in time and space. How much benefit can be attributed to each factor? Contrast this with the immediate and almost universal application of the 55 MPH speed limit. By occuring at once, it was relatively unaffected by the wide range of influences which would have obscured the relationship between speed and accident rates had the limit been phased in and been made applicable to cars produced after a given date.

This illustration is prefatory to discussing the timeframe for research projects. The Department is faced with a variety of problems. Some of these are long-term and solutions are sought in the year 2000 and beyond. Some are as immediate as the headlines and must be resolved TODAY. I would like to ask this conference to consider the midrange period. We must get beyond today's problem and consider what the problem will be like after today's solution has been implemented. What decisions will we be faced with three or four years from now and which will extend to the seven to ten-year span? From statement of problem through solicitation, proposal, review, award, research, publication, and development of departmental program based on the research, budgeting, funding, and execution, we are dealing with a minimum of three, and more likely five, years.

So, the minimum timeframe is five to seven years. At

the far end, we are not seeking solutions to the challenges of the year 2000. This conference must focus on steps which can be taken in the midrange, seven to ten-year period, which will assure that problems of the year 2000 and beyond are considered. In short, consider not what we must do in the year 2000, but on what we must do in 1980 and 1981 to ensure that we will arrive at the year 2000 in the best possible shape. If we can't do this, then the year 1980 will be on us and it will then be too late to do any R&D. Forward thinking, forward planning, is the key we are seeking.

As a final point I would like to emphasize that the aim of this conference is not to have this distinguished group focus on solutions to problems. I am confident that having reviewed the Secretary's statement and the conference guidelines you would agree that solutions of these problems in a two-day period would be a most ambitious -- and unlikely -- achievement.

We want to surface these problems because we feel that they have been underrepresented as problems. Let this conference try to clarify the issues and define problem areas in inter-modal safety research. Let the modal spokesmen try to nail down their problems in specifics, stating clearly how they see the problems and the potentials for improvements of various possible solutions. Let the university spokesman describe any possible analytic tools or techniques which may be available and which have not been considered by the Department.

As a result of this conference I hope that there will be a better understanding of safety needs by research groups and a complementary understanding by DOT representatives of the capabilities and limitations of research efforts. This understanding should then translate itself into a three-fold improvement.

First: There should be a better articulation of the DOT research requirements as seen by DOT safety program managers,

Second: There should be submission by the research groups of proposals which are more responsive to the needs of the Department, and

Third: There should be a more knowledgeable review and evaluation process of such proposals by the Department.

The basic purpose of this conference is to identify the inter-modal and the multi-modal research requirements of the Department of Transportation. We have covered a lot of ground in a very short space of time; I could not have done this with a less aware and less responsive audience. I want to leave you with this thought: Good ideas, even great ideas, must be developed and sold in the marketplace; they are not instantly apparent. Our safety problems in the Department are not merely the lack of technically competent concepts; they are primarily the inability to convince ourselves and the nation that the program involved optimizes our resources, is technically and economically feasible, and, most important, is achievable given the social and political climate. Give us the methodologies to select such ideas, to test them and evaluate them, to compare them against alternatives, and to convincingly make a case so that public acceptance will follow. That is the most important multimodal research requirement.

PANEL I:
"INSTITUTIONAL PROBLEMS IN TRANSPORTATION SAFETY"

Moderator: Donald W. Bennett,
Federal Railroad Administration

OBJECTIVE: To clarify research needs in the area of institutional factors.

PANEL DISCUSSION AREAS:

Ia Federal-State-Local Relations

Who is best able to handle each aspect of the safety problem? Who has the responsibility under law? If differences exist, can they be reconciled?

What is the impact on State and local governments of differing enforcement strategies (regulation, incentive, persuasion, licensing, certification, fines, court action, et cetera)?

What is the impact of safety programs on State and local institutions (public funding, public services, education and training)? How does this vary if the same goal is sought through programs for accident avoidance, accident survivability, or accident recovery?

Is there an optimum attainable responsibility among Federal, State and local authorities?

Ib Federal-Industry Relations

How much control is required to achieve a desired level of safety?

What has been the impact of safety standards and regulations on industry (safety, services, prices, energy use, economic viability, competition)?

Have safety programs caused distortion in competition or affected competitive entry in the transportation industry?

What is the impact of different enforcement strategies or intra- and inter-industry factors (regulation, incentives, persuasion, licensing, certification, fines, court actions, et cetera) on safety, by modes (past and present)?

Have Federal funds for safety technology reduced or increased industry research and development? What is the proper mix?

Ic Federal-Public Relations

Has the representation of public interests been productive or counterproductive in setting safety standards?
How can the public's willingness to accept higher risk and lower cost (or conversely to pay a higher price for a lower risk) be determined?

What conclusions can be drawn from the public's apparent willingness to accept different risk rates in different transportation modes? Are institutional factors present (consumer groups, user groups, employee or other special interest groups)?

MR. DONALD BENNETT, FEDERAL RAILROAD ADMINISTRATION, MODERATOR OF PANEL 1
WITH MR. PHILIP BOLGER, DIRECTOR, OFFICE OF SAFETY AFFAIRS

MR. BENNETT: This, of course, is the first time now that we have a chance to have some discussion. We had a number of good remarks this morning from the government people and from some university people, both as to what the needs are and what some possible approaches are. What we want to do now is to start exploring those things in greater detail. As Phil indicated, we are not looking for solutions, but we want to share with each other what we perceive to be the research needs and what we perceive to be the tools and approaches to address those research needs.

The first panel, I think is an interesting one, "Institutional Problems in Transportation Safety." I don't believe this is a hardware discussion that we will have. I don't know that institutional problems can be solved by hardware approaches. Maybe I should put that as a question and see how we go on that.

The three basic areas we are going to discuss will be, first, federal, state, local relations; second, federal-industrial relations; and finally, federal-public relations. Let us start with federal-state-local relations. If you notice in the guidelines to the conference, about the middle of that, we have an outline of the question issues that this panel should be addressing. I know that the Federal Railroad Administration and other modes in the Department do have federal-state partnerships, if you will, to address the safety issues. I think each of the modes has a slightly different federal-state partnership and a different approach where the roles have been divided up differently between the Department of Transportation and local Departments of Transportation or local regulatory authorities.

Who is best able to handle each aspect of the safety problem? Who has the responsibility under law if differences exist? Can they be reconciled? I suppose implicit in these questions is where should the responsibilities be? Let me read the rest of the questions here in this to get us started. What is the impact on state and local governments of different enforcement strategies, for example, regulations versus court action? What is the impact of safety problems on state and local institutions? How does this vary? Is there an optimum obtainable responsibility among federal, state, and local authorities? As I indicated before, I know this is a problem with the Federal Railroad Administration. I perceive it also is a problem with other administrations.

Would someone like to jump in now and help me get the discussion started on these federal-state-local relations? Would someone like to share some information as to needs or tools?

MR. FOLEY (Federal Highway): Our traditional relationship for highway construction has been through the state highway departments. When you get into the highway safety programs, we find that we have to get farther down the line and more involved with the local jurisdictions. This seems to be where the action is as far as getting results, saving lives, and reducing the other losses, and it is a difficult problem from the federal point of view to really sit down and recognize that what we are trying to do is give them guidance and support and let them make the decisions and part of the reason for that is in so many instances, they are understaffed or not staffed to tackle these kinds of problems for us, so that gets back into education again. There was some reference this morning to training programs and so forth. This is, I think, an area where we could get some support from the universities.

MR. BENNETT: Thank you. I think that is a very good identification of a need and I would agree with you.

MR. E. MARGOLIN: I would just like to raise a question. We have reciprocity among states. Is there any prospect or is there any kind of reciprocity that goes on between states in terms of research and research priorities and research needs? Is there an exchange of information? I am not talking about TRISNET, now, beyond that.

MR. BENNETT: That is a good question. Is there a mechanism for that kind of an exchange of information? I would assume that to some extent the Department of Transportation will do that in those kinds of areas that Mr. Foley was talking about, but there must be a bigger area that is a particularly a state need problem.

MR. RABINS: Yes, there is such a mechanism. A gentleman by the name of Alphonso Linhares in the Office of the Secretary has the responsibility of technology sharing. He works with the Urban Consortium. This involves mayors and their staffs in 30 cities. They use the DOT TRISNET, TRIS on-line, and TRAIS systems.

MR. E. MARGOLIN: In other words, it is more than hardware?

MR. RABINS: Yes.

MR. E. MARGOLIN: Well, how well known is this?

MR. RABINS: It has been underway for over a year.

MR. E. MARGOLIN: Well, do all of the constituent agencies of DOT have an input, then, as well?

MR. RABINS: All DOT administrations have a point of contact and OST, FHWA, and UMTA are active participants.

MR. E. MARGOLIN: Because we are talking inter-modal, there should be inter-modal agencies, so to speak.

MR. BENNETT: Well, I think you are also there talking about inter-governmental sharing.*

MR. HANBURY (National Fire Prevention Control Administration of the Department of Commerce): I have learned a lot from the conference here and I think it is very good and I think it goes back to Dr. Grimaldi's remarks and what this gentleman is saying, you need to, I believe, lift your sights a little bit further than just DOT. I have been appointed inter-agency coordinator for NFPCA in the fire field, which includes local, state, and federal. Primarily my interest had been in the federal area, but it is amazing the number of federal agencies that are also wrestling and have worked in the problem of local and state technology utilization, and what have you. For example, the Federal Laboratory Consortium effort to transfer technology, so there is a lot going on and what I am trying to say is I think that you need to raise your sights and include all federal agencies in your sphere of interest, not just DOT.

I would like to give a few observations that I have, if I can, a little bit off the subject of state and local governments, though.

*Editor's Note: For further discussion see the Fourth Workshop report (Role of Government in Transportation R&D) pages 137ff.

MR. BENNETT: I certainly don't mind, but I would also ask do you have any suggestions as to how we raise our sights and which I think you mean information sharing, both needs and tools sharing.

MR. HANBURY: Right.

MR. BENNETT: I don't know if we need some sort of larger government clearinghouse for that type of thing.

MR. HANBURY: Well, I think one of the things that has not been addressed, everybody is saying that there is a need for a data base and so forth. What we have found in the fire area, for example, is there needs to be a translator that sits between the researcher and the user, someone who can look at what is going on and really make some conceptual judgments based on his detailed knowledge of where they can make use, and full use, of the information; and then be able to talk to the user in terms of using it. I think there should be some commitment of resources and manpower in this area in DOT as well as other agencies, to translate between agencies as well as between the academic community or the research area and the user, sort of what the gentleman was talking about earlier of putting out "listening posts." You need to put out "enabling posts" also.

MR. BENNETT: Well, I think Judith Connor this morning spoke on that. Is that an area where the universities can help us with either the exchange of information or setting up a medium of sharing knowledge? I think that is a very good question you are asking

MR. HANBURY: I think it would be very good. I haven't seen any of the research areas or proposals calling for somebody in the academic community to come into DOT, for example, and spend a summer as a fellowship in this area to get a little better appreciation when he goes back, to be able to fit closer your needs. I would think this would be a way to do that.

MR. GRIMALDI: There is one problem when we are talking about university research and the kind of contributions they might make that we ought to make clear to each other. It costs money to write proposals. Right now it costs us something like $3,600 per proposal. That is not out-of-pocket expense but that is time that faculty are investing in the prospect of getting a successful contract and we all know that more times than not we are unsuccessful, so under the circumstances, the university, particularly the private university, and I think all of the universities these days are in the same fix, judges very carefully how the effort of its faculty is going to be spent on prospective work of any kind, including some very important proposal writing that might be done.

Also, when we get to specifics with respect to what the agencies are interested in in terms of priorities that you have established in connection with the major needs that the agency sees that have to be met, what it interprets Congress is asking for, for example, those priorities may not fit the academic interests of the university, and universities are not research centers. They are interested in research primarily because they can get information from it that enables the university to increase its academic programs, which is the principal business of a university, so if you are looking for answers to problems from the university that might not fit the academic interests of the programs in the university, you are not going to get that help from the university.

Finally, those areas that are, from our point of view, very important problems just never appear in the agency's prospective interests. I am an elected official in the town I live in out in Long Island, and we are talking about coordinating now the state and the local administrator functions. This was the point you raised, Mr. Bennett. We have a great deal of trouble primarily because there is a state highway that borders on our town with certain traffic problems that are associated with it which the constituency in the town holds us accountable for but which we have no control over. So we write to Albany and call Albany and try to get some improvement in the attitude up there in the Motor Vehicle Department with respect to controls that have to be used, and we get word back from the capital saying that, well, according to their figures there have been only four accidents in the past two years on this particular highway. They don't feel that it has quite the urgency that some other matters have. There is a limited amount of money available in the capital for doing the highway work throughout the state. We are a relatively small town to begin with, so they don't tell us this, but we know it, we have very little political crunch. We are entirely Republican in our town, so that with the Democrats in Albany, we don't make any progress there at all.

So what we are really coming up with in terms of our interests with respect to bringing about the kind of control that you want is some means for making accountability a little bit more strong in the political hierarchy of the state. It isn't until we have done that that we can get all of the units of the state falling into line and doing their job. As long as the people of the town who elect us say that we have the responsibility for controlling the transportation problems in our town, but where we in turn have to go to some other agency that has the responsibility, there are two people who are responsible, or two agencies that are responsible for performance in this case and from the management point of view where there is more than one person responsible for anything, literally nobody is responsible and here is where the systems breaks down.

Now, an important piece of work to be done in this area would be along those lines. I daresay if we wrote a proposal on something like that that we would not be successful with it.

MR. BENNETT: I am very glad you didn't use the example of the trains blocking your grade crossings, for example.

MR. GRIMALDI: That is one thing that has happened.

MR. BENNETT: I wouldn't doubt it. I think that is what this panel is all about. Is there a need or a mechanism to clearly define safety responsibilities among the various jurisdictions, federal, state, and local?

MR. HESS: I would like to respond to the gentleman's comments with regard to university research. With regard to the first point that I think he raised, all cost developing proposals are allowable costs and may be indirect charges as part of the audit procedures that your university is under and may in fact be recovered through the research process. Second, is that many of the larger university systems in the country do, as a matter of academic policy, maintain associated or in-house research facilities.

MR. GRIMALDI: For the sake of clarity, I don't want to belabor this, sir, and you are quite right, but you only can

recover the cost when you are successful with your contract or your proposal, and we have written roughly 30 proposals for every one we get, so you can see that the expense would go up and in-house research can be supported by a university only to the extent that funds are available for it and in the financial crisis situation that universities are in today, there is very little opportunity for much in-house research funds.

MR. RUSSELL (Kansas State University): Of course, not being in administration, I wouldn't know about the cost, but writing these is a hell of a lot of work and I have got to do the work and I think there is a need along the lines of technology sharing. If you could develop along those lines some needs sharing so that it would be easier for us to find out what the needs are, I would like to say, of course, calling various people in various sections is one way. I have never talked to anyone that wasn't cooperative and friendly, but sometimes you have to call five or six people to find out who is interested in an area that you are working on, to see if it has already been done or if there is a chance it will be funded if they have an interest. I think there is more need for this across-the-board interest, or across-the-board needs, some clearinghouse for needs that you can get a quicker response and so forth.

MR. DICESARE (Renssalaer Polytechnic Institute): I would like to add to that comment that perhaps a way to get around this idea of, let us say, $3,600 per proposal and 30 proposals for one success, might be a technique of pre-proposal or small proposals to sort of match the needs and then if the Department is interested they would ask for a broader proposal or in-depth proposal from several universities. At least the university would then know they have a chance of one out of three or one out of five as opposed to whatever the ratios are, four out of 200.

MR. RABINS: I think several issues have been raised sequentially and it probably would help if you know a little bit more about how the Office of University Research handles proposals and how it views the proposal writing action. We very much welcome pre-proposals but preferably not in writing because that doesn't help you and it doesn't help us. What we welcome is informal contact. If you call the Office of University Research with your proposed idea, more likely than not, we are not going to be expert enough in our immediate office to be able to intelligently interact with you, but what we can do is put you in touch with the professionals in the Department working in your area. They will most likely be the reviewers of your proposal when it comes in, and this informal prior conversation to identify needs is one of the best ways to increase the chances of your proposal and decrease the rate of proposal failures. That is the recommended pre-proposal route to go, before pencil ever gets put to paper. The safety needs we are hearing about today are input to help you on what the safety research needs are that the Department should be pursuing.

Now, one of the criteria that gets surfaced in the review of the proposals when they go through the review process is relevance, and that is one of the strongest criteria. The relevance criterion means how closely are you connected to a perceived need of a DOT professional that might have to act as the monitor of your research. He is not going to be enthusiastic about giving glowing grades to your research proposal unless it is connected to the needs that his boss is pushing him on here and now. It is important before you ever write the proposals that you find out -- and I am not just talking about DOT now, I

am talking in general, wherever you submit proposals -- find out the needs of the people that you are going to have to be dealing with who are going to review your proposal and who will eventually, if it is successful, have to monitor it.

MR. GRIMALDI: Mike, therein is a weakness, if you don't mind my breaking in. Because you are looking for fresh ideas. I am not saying that there is any lack of freshness in the administration people who are reviewing these notions, but as somebody comes up in a university with a line of attack that is unconventional but has some promise, in the opinion of the university-type, the chances of being successful with it become reduced under these circumstances. We are forced more and more into a groove which is what you are trying to get out of.

MR. RABINS: Well, Professor Grimaldi, with all due respect to us academics, our total credibility here in Washington can be vastly improved upon.

MR. GRIMALDI: I know that.

MR. RABINS: The program that I am now directing is three years old and for the first three years of its operation it has been essentially, "Okay, it is your nickel." "Give us your best ideas." Frankly, the program has not been as successful as it could have been, from perceptions and the perspectives of the hierarchy in the DOT and in OMB and in Congress, who control the flow of money to you through our office. I am in agreement that it can be more successful and this conference is one of a number of exercises that are being undertaken by the Department to try and get more money flowing to the universities on a more effective and directed basis and more research back to the Department.

MR. PIGNATARO: The comment that the universities in their overhead structure can absorb development costs as far as proposals are concerned is not true as far as my knowledge of the universities is concerned, contrary to private industry where they can be absorbed. Another comment was made that most universities have some kind of research center separate and apart. Well, many universities are forced to go into that mechanism to recover some of these costs, which is what Dr. Grimaldi was talking about.

Another point that I want to make, also following what he has said and following what Dr. Rabins has said, it is true that universities may not have been as responsive to the desires of Congress as Congress would have liked, but as usual, we are taking a much shorter range view of these things. The main reason that universities exist, as was already stated, is the training aspect of our work and unless our research can not only be translated into the classroom, as Dr. Grimaldi has indicated, but also be in a position to support some students, then it becomes quite questionable. Yet, we have been doing a good deal of research where those aspects have not been as encouraging as they were in the past, so that the involvement of the universities, and we need to involve them more, we all would certainly second that, but there must be a cognizance of the fact that we are in business primarily to educate and train people and the research must have some association with that.

MR. WAKELAND (National Transportation Safety Board): I want to risk upstaging our chairman, Webster Todd, who is going to be the dinner speaker tonight, but I just want to respond to Dr. Grimaldi's point about the short-range versus long-range research and the unconventional. It is not necessary to rely

entirely on the perceptions of the DOT modal experts to get approval of unconventional ideas. The National Transportation Safety Board has its own perspective, and while it does not have any research money, it can recommend the research to the modal administrations and the Board has in fact recommended a good bit of unconventional research where we have shown with it that it was not necessarily cost beneficial but there was a good reason to think that it would produce a result if carried long enough, so the only point is you are not limited by the administration's approach on a technical basis. There is another section of the government that can look at it in other ways. You can also look at the same subject areas in agencies other than DOT and sometimes you will find it.

MR. BENNETT: I don't know if I should comment on that point or not, but I think you bring up a good point. Judith Connor mentioned the fact that one of our questions is "are we addressing the right problems?" Many people do set our priorities in addition to our own look at what the priorities should be, especially in the safety area. As far as the Department is concerned, the National Transportation Safety Board also sets some of our priorities. Congress sets some of our priorities. The industry that we deal with will set some of our priorities. The employees that we deal with will set some of our priorities. There are many people that do have an input on our priorities and I think that you of course are included in that large group. What you have to do is convince us, of course, that it is an area that needs to be addressed and all of those people who are setting our priorities are competing for very scarce resources, and I guess that is part of it.

MR. J. MARGOLIN (George Washington University): Speaking to this issue of priorities and the way the institutions function -- this can serve a counter-productive purpose at times with regard to the innovative or creative kinds of research that I think Professor Grimaldi was addressing. If you work with priorities and pass those around, then you immediately begin to limit some of the areas of potential research which may have been spotted in the university or in the community, and universities do interact with communities more frequently than is known. I wonder if there isn't a slightly more efficient way of handling this. DOT is following a set of procedures. That is a bad way to put it, but NIH and the Office of Education, and all of those huge funding operations, set up exceedingly complex procedures which were used, as a matter of fact, because of the cost and the energy that Dr. Grimaldi described, as a deterrent to proposals, and in a sense it winnowed down the numbers of proposals that might be received so that they could be handled administratively. Yet here we are searching for creativity and I wonder if one of the things that might be done would be to simplify the initial phase of this so that a concept piece of no longer than a page or even a half page, if it could be done that way, would suffice. In terms of the classical mathematics dissertation, you know, that is done with one page of equation and an explanation of it. The capability of the organization to do something about that particular issue should also be demonstrated, something that wouldn't cost more than a couple of hundred dollars and some staff time. Put that into the system, direct it to the very people who are serving as critics to university research's selection of subjects and the final product that would come out. Let them decide what kinds of things they want to have you work on, expose them to the new ideas, and then when the organizations or the ideas have been selected out, urge those that are desirable, to proceed to develop a proposal with somewhat greater likelihood that they may have a fair chance of getting it. This would save,

in terms of the national economy and our gross national product, all of those high-flown terms, a heck of a lot of the energy of our scientific community and perhaps select down a few more useful areas as well as educating some of our administrators. It is a way of maybe short-circuiting this system and being more efficient. Has it ever been tried?

MR. RABINS: Well, specifically, no, I don't know if it has, but Joe, in general terms, I can assure you that there have been very tangible successes from the first three years of the Office of University Research program where it was left totally unsolicited. I don't think there is any argument that we don't want to turn off creativity and innovative thinking. I am sure in the future that some of our funds will be set aside for totally unsolicited ideas, for, as I said before, "It is your nickel, give us your best shot." Our intent is not to steer the universities into research straight jackets or "a priori" solutions. Our intent is to identify needs and problems, not RFP's, but problem areas where the universities most intelligently could contribute, where they have capability, rather than just having wide open solicitations. What we are saying is let us identify the needs that are most relevant for the Department of Transportation in safety where the universities could contribute intelligently, not to stifle innovation, but just to identify problem areas.

MR. J. MARGOLIN: I guess the basic question is how to get that $3,600 down to about $600, if we could; that is the problem.

MR. BENNER (National Transportation Safety Board): Isn't there an implicit assumption in your approach that the need is identified with your first and best shot? I think what the gentleman was suggesting is a mechanism by which you can progressively refine the statement of need, a $200 letter to get a $1,000 follow-up contract to develop a $3,000 proposal to develop a $50,000 study, did I understand it correctly?

MR. J. MARGOLIN: That would be one way of doing it, yes. It might be a very good way.

MR. RABINS: I know of no such plan.

MR. DICESARE: I guess one might ask how many proposals has the program received versus how many it has funded to determine if you use a ballpark figure of $3,600 per proposal you could determine in dollar value how much effort has been expended versus the successes.

MR. RABINS: The numbers alone do not lead to a total understanding of the situation. In the first three years of the program, 1,134 proposals were submitted to the Office of University Research, and 112 were funded. This year, 258 new proposals were submitted and 33 were funded. Those numbers are a little bit misleading because they represent multiple submissions in several cases of something that is submitted a first year, a second year, and a third year and which maybe gets funded in the second or third try. Or perhaps the proposal was handled by another government agency.

One difficulty with the kind of pre-proposal or the scenario that you are proposing, is that the review of proposals in a mission-oriented agency like the Department of Transportation is an in-house review by the professionals within the Department and, as such, involves many people and a great deal of time. If you are now going to have a sequential review in the fashion that you just outlined -- first a call, followed by a

letter, followed next by a proposal -- it makes an already ponderous review process even more difficult to manage.

MR. BENNER: But maybe the review process needs to be streamlined.

MR. RABINS: No doubt about it.

MR. BOLGER: Mike, I would like to just comment on the activity before you got here. Mike has got this thing, it is refined fairly well, but I have really been instrumental in reviewing, I would say, 100 and some odd, proposals in the safety area and I guess I could say that 50 percent of them were so modally-oriented that they drop out. In other words, they shouldn't have been submitted into this system that we are talking about. They were not multi- or inter-modal. Then of the remainder, a good portion were advertised as multi-modal, but really never achieved that in our minds. We couldn't see it. I guess I could say that of all of those proposals, maybe only 10 were really on the mark or were worth working on, so that in 90 percent of them, those guys have wasted their money. It seems to me that maybe there is some value to that kind of a first look at it where a screening of a simple submittal might get rid of a lot before people put all of that effort into it.

MR. RABINS: Streamlining is a good goal, but at the bottom line, it involves people and time and priorities. The proposals are reviewed by the professionals who are working on the problem. Pre-proposal submissions must compete for their attention and time to give you a fair review of your idea. Out of fairness to you, you want that to be a careful review. You want them to take the time to give you a fair and complete reading. Now, whether that is done the way we are operating now or by a different mechanism with the kind of scenario you outlined, that is not important. At the bottom line you have to get the professionals to give the time. There are other priorities, and the streamlining takes strict management of the process to get the people involved.

I think this kind of conversation and exchange is important, but it is rather far afield from the subject of this discussion. It probably should be discussed so we know in what context we are discussing the research needs, but I would hope that we wouldn't spend the whole afternoon on it and we could get back to talking about the research needs and priorities.

MR. BENNER: Relevant to the point that you just made, I hear coming from you a request for a proposal at the end of the gestation period when in fact research is the development of new ideas and the growth of those new ideas. Whereas, you are asking for, really, a development proposal rather than a research proposal, and it relates directly to the question that you are posing here. You are trying to identify a problem when part of research is identifying the problems.

MR. HAWTHORNE (Association of American Railroads): This is on the same subject. Missing in some of these proposals is the salesmanship. There is a lack of salesmanship and that starts a long time before it ever goes to DOT, because of the matching funds section within the university thing. We funded several of these and the thing is that the approaches aren't made. We have never been approached on the safety issue for joint funding. We have worked in other areas and the thing is there are a lot of sources to sell this to first. The fact that you have sold it to the ultimate users is an indication to DOT

that at least somebody has an intention of using this material once it is produced.

MR. WAKELAND: May I ask a straight question of Dr. Rabins? Do you make, in the university office, any effort to communicate points of problem areas or points of capabilities to the agencies that might assist each other or cooperate? University groups together might be able to produce a stronger proposal than they would individually.

MR. RABINS: We have funded research consortiums. I believe there were five contracts in the first three years of the program that were consortium efforts. I don't know how they grew, whether it was external or internal inducement. There has been, as in any research effort, successes and failures in the consortium efforts. These go back to pragmatics of management of the research, communications, funding, and timing.

For the most part, the consortium research has been fairly successful. We haven't made any specific effort that I know of, after the fact, if I understand you correctly, after the proposals come in, to put universities in touch with each other, that proposed in the same general topic areas.

MR. HAWTHORNE: There has been at least one case I know of where that was done, the Arizona work.

MR. RABINS: Yes. Usually it was done on an ad hoc basis. There is no formal, pro forma effort. However, it is not a bad idea.

MR. WAKELAND: Well somebody has to see the possibility there in order to put the right agencies in contact. Maybe that would be a useful function.

MR. RABINS: Well, one effort we are making is in its initial stages. We are trying to identify the interests of all of the people who have proposed to us, all of the people who have ever put themselves on our mailing list, about 4,000 people. More than 40,000 items are involved. This requires a computerized print-out tied in with TRISNET. Now what we have considered so far are the reports, papers, books, and publications resulting from the research program going out to the selected mailing list by area of interest. Your idea is an excellent one. Why not the proposal also? There is a proprietary question and we will have to be careful.

MR. WAKELAND: I think it is something like the qualified bidders list that is used in aerospace.

MR. RABINS: Yes.

MR. WAKELAND: In that you are known by certain areas of interests and you make a bidders list available to others and they can see who their friends may be and ---

MR. RABINS: Yes, but that should work from the other direction also. The university that is in an area like Arizona, the example that was cited, they should know that there are other professionals that they could see at meetings, whose literature they read, who they should naturally and informally be in touch with.

MR. WAKELAND: They should try it themselves.

MR. RABINS: Sure.

MR. LACEY: It does work in the other direction, especially when RFP's come out. If it is in your area of interest, you know the other people who have strengths that you might not have contact with.

If I could just address a couple of points that were made very briefly. Mr. Bolger was talking about how many of these proposals just drop out because they don't fit the basic general requirements. It seems to me that a clerk could decide which of the single page proposals that he is talking about being submitted don't meet his basic requirements. It wouldn't take a professional in the area necessarily, but maybe just a generalist to do this initial shuffling, and then the point that Dr. ---

MR. RABINS: Well, do you think you really want that?

MR. LACEY: Well, the way he was describing it, that they just so obviously didn't make it, I am not saying it is a clerk but perhaps he could give them a quick review or you could give them a quick review if they are really so far off the mark.

MR. BOLGER: Yes, I would rather review 100 one-page things than 100 100-page proposals.

MR. LACEY: Right. The point that Dr. Pignataro tried to make in response to Dr. Hess' comments is that you can recover proposal preparation costs in your university overhead. The university may not give it back to the Department. You may not see it, but the university recovers it, and I am sure every large university has it in there.

MR. BENNETT: Let us see if we can have just a few more comments on this general topic. I know that it was on your mind and it is good to have that kind of a preliminary discussion, but I do want to get on to this area of the need that we have identified, just a couple more on the other issue, then.

MS. SIMPICH: Yes, it is not the other issue yet, but I wanted to ask you how much money in those four years that you were receiving those 1,134 proposals have you given out?

MR. RABINS: If I remember correctly, $11.27 million for three years.

MR. SIMPICH: Well, then the proposal costs is $4 million, that is $3,600 times 1,134 proposals.

MR. RABINS: Well, we are assuming that number. I do not know if that is the cost of a proposal preparation or if that cost should be amortized over the multiple submissions of a proposal which is not successful the first time submitted. Whatever the cost though, that is not a cost to the government and it is not directly comparable to the funding level undertaken by the Department. We don't know if that is the correct number. That is not a cost to the government, though.

MS. SIMPICH: My point is that it might be well to consider a two-page pre-proposal and then you would have to talk about what would be in that, but not today. I mean you can be so general in a one-page pre-proposal.

MR. RABINS: I don't mean to give the impression I am defending something that is cast in concrete. I am just managing something that has been set up for the first three years of the

program. Your points may be well taken and maybe it is worth considering that as an alternative approach. It is a valid issue.

MS. MISCH: Mr. Bennett, you said much earlier that you were interested in discussing not only current issues but somehow before the problems overwhelm us five or seven years from now, being able to take a look at growing problem areas and growing issues that will be big then, and I am relating it to this process of university research funding, not yet on the subject of this afternoon's panels. I think the problem that is very real in the light of university economics today is short-term funding. Because you lose people, and I realize that you who are sitting here may have no control over this, year-at-a-time funding is not optimal toward developing interest among researchers that will be responsive to your needs, particularly when it comes to being able to see, predict, follow, problem areas that are now small, but that will be large. I am not asking for a solution, but just making a statement.

MR. RABINS: The mandate of the Office of University Research is by Congressional appropriation on an annual basis and the office is allowed to fund only one year at a time. But let me give you some insight. In addition to the 258 new proposals, there were also in the last cycle 15 renewal proposals. Recall I said 33 of the 258 were funded of the new proposals. Of the 15 renewal proposals, 12 were funded, and it is almost an a priori assumption that a renewal proposal is going to be refunded if it is delivering what was contracted to be delivered. The research results, if on target, if on time, if the monitor is supportive of the research, almost guarantees multi-year funding if the original research proposal laid out a multi-year effort.

MS. MISCH: It does require it.

MR. RABINS: But there are constraints.

MS. MISCH: I realize you are operating under Congressional constraint.

MR. HARTON (Materials Transportation Bureau): As I listened to what you were talking about here, it sounded as though there were quite a bit of procurement involved here. There are certain procurement regulations which must be followed, and possibly one of the problems is the procurement process itself. I recall also that there now is in existence a Federal Procurement Policies Act, I think, a rather recent development, and maybe the group should look at the overall procurement process, because there are certain restraints and certain procedures that you have to go through with this type of operationl so you have to stay within those parameters, whatever they are, but perhaps some recommendations as to how that process might be improved would be worth considering.

MR. PIGNATARO: I just wanted to say something with respect to bringing groups together. Mr. Wakeland had asked a question about this. Well, your office and Phil Bolger's office did bring two research groups together, not in a formal way, but the University of Illinois is doing work that is associated with the work that the Polytechnic Institute of New York is doing. Both projects are being monitored by Mr. Bolger, and his staff, so that you did bring the two groups together to see if their work could be more complementary.

MR. RABINS: That is what Mr. Wakeland was suggesting that we do.

MR. PIGNATARO: No, but it still was an attempt on the parts of the people involved to bring those groups togeher.

MR. BERKHOUT (University of South Dakota): I don't think the government is pushing its case too hard here. You are acting very apologetic in the face of all of these hungry people. I get the impression that the University Research Program assumes that there is a university system out there that is doing something before the government comes in there to buy it and that in their spare time, perhaps, they might be able to come up with a little extra work oriented in ways that might be useful to the national government.

The assumption that seems to be behind most of the comments people here are making is that the universities do practically nothing until the federal money becomes available and they want it to be available on the longterm basis, and it seems to me that there is sort of a basic assumption here that the universities really aren't doing anything of their own continuity and don't have programs that can continue without government funding and I think that is not the assumption on which the original Office of University Research financing was arranged. The assumption was that there are continuing on-going programs funded by states or funded by private foundations, but that that would be a large on-going project, portions of which could be redirected by additional federal money. Here we are making the assumption that somehow the whole system is going to collapse unless continual federal money from your office is pumped in and I don't think that was the original assumption on which the program was founded.

MR. DICESARE: I would like to disagree with that. If it wasn't originally intended, it should be somewhat intended that way. It seems to me, just to make an analogy to the aerospace industry, we never would have gotten to the moon if someone relied on the research that people were doing and just added a few bucks to it to do things their way a little bit more. I think that there was a very large university research investment at that time which had results and I think if you want results in this endeavor, in transportation, then you have to have the same sort of commitment to support universities for an extended period of time so that they can gear up to solve the problems that are at issue. It may not be the University Research Program they were talking about in particular. This is a very special program, but I think in general, if the government wants the universities to participate in the solution of problems it has to commit the funds to that endeavor.

MR. RABINS: But the times, the ambience, and other things are changing. At the risk of sounding somewhat apologetic or even getting argumentative at the other extreme, which I am trying not to do, when the program was first set up in 1971 by Assistant Secretary Cannon and Professor Herbert Richardson from M.I.T., who was the Chief Scientist of the Department of Transportation, their initial hope was to start it out at a level of funding of $5 million the first year, $10 million the second year, $15 million the third year, and the sky is the limit thereafter. They wished to let the money flow exactly as you are indicating for creativity, innovativeness, and to let the universities contribute whatever good ideas that they can in solving the transportation problems. That was perhaps a holdover from the -- personal speculation now -- from the times of the late sixties, and the centers of excellence, and the Sputnik era.

The times have changed and the political waters are different now. The tone in Congress and OMB is very much, for example, against grants. They want contracts, not just outright give-away money to the universities, as witness Senator Proxmire's NSF head-hunting on "silly-grants-topics." The tone is very much a short-term, short-vision view of what is the money that we are giving to the universities going to do for us now. That is a very much different tone from earlier times. Congress and OMB, in trying to get specific results from the universities, see them differently from the initial intentions for the program. That is one of the reasons, incidentally, that we are trying to be more responsive to perceived needs that we can all agree on, so that we can make more of a case within the Department, in OMB, and in Congress, to get more money into University Research and more specific results coming back. That is, again, one of the goals of this conference.

MR. J. MARGOLIN: I know you want to get on, and so this is kind of a suggestion in the context of what Dr. Rabins has spoken of earlier, which was the grouping of various universities and other organizations by interest, and I feel this, I encountered this sitting on a PRB committee a couple or few months ago. We had two meetings for a particular act of PRB grants and they were both very good. One of them was excellent, theoretically, and the other had tremendous capability for communicating their work to state and local organizations and operating programs. We had to choose between them, and frankly, the thing I am ashamed of is that it never occurred to us to try to bring them together, and so what I am suggesting , Mike, is that there may be a two-by-two matrix here, in the sense that there is content and there is communication capability, and if you can begin to group them according to both, maybe you could begin to get better combinations of projects.

MR. BENNETT: Mike was here to be a silent co-chairman and he has been on the hot seat for a while now. I do know that these issues are underlying a lot of concern and a lot of thought, sort of an overview of the whole university research program and when we all are brought together, these ideas just need to pop out and we need to discuss them, but I do think we have. I am afraid Phil is going to fire me as a moderator unless I try again to move the group on towards the ideas of clarifying research needs in the area of institutional factors, because this is an area where the Department has indicated we perceive a need. We perceive a problem. We perceive many things in this area, federal-state, federal-industry, federal-public relationship. What can we share in regard to defining that need or the tools and approaches that we ought to look at to address that problem?
Does anybody want to address that topic?

MR. HUMPHREYS: Mr. Foley indicated that the federal agencies now like to let local agencies make some decisions, or many decisions, or what have you, and we see several results of that type of thinking. To carry it just a little further, you indicated that the local governing agencies frequently were understaffed or didn't have the training and so forth, so one of the things that universities could do would be to provide these training sessions, et cetera, et cetera.

One of the things that the University of Tennessee has done, if we haven't done many other things, is to attempt to do some training in many areas of highway operations and traffic operations, safety activities and so forth. I find, however, that in my work with many of these agencies there is a lack of initiative on local government agencies if anything is going to

cost any money. There is a very distinct lack of initiative on the local agencies' part and I am concerned that we perhaps don't have the data. Maybe that is what it is. We have policies on the federal to state and state to local hierarchy. We have policies requiring implementation of certain safety standards here, certain safety standards there, but either we don't have the data to back up those policies or we don't have the money to back up those policies or something.

For example, concerning the lawsuit filed against the Federal Government and State of Virginia reference the I-495 controversy. I think there is distinct area for research as to how or what enforcement rules or what the enforcement policy should be. How do we go about getting local agencies to respond to policies which are set down by a higher level agency. I don't think what we are doing now is very effective at all.

To me this is a research area. You now have said, well, we will withhold monies. That hasn't worked. How do we get them to do it? Is that a researchable area?

MR. FOLEY: I guess, John, one of the things that started percolating through my head while this other discussion was going on was that the universities by and large are in localities. They have an opportunity to observe local kinds of problems and in some instances, in your case, you are working with local jurisdictions. Out of all of this there might come a problem that you perceive that we in the federal establishment don't and if you could fire that one in.

MR. BOLGER: Are you talking about ways in which the federal government can get more compliance with their, say, the highway standards, et cetera? Is that what you are talking about?

MR. HUMPHREYS: Right. It seems to me like under the discussion area outlined here how do we get compliance? Who best is able to handle some of these problems, and they are talking about state and local government, enforcement strategy, et cetera, and I thought that we were looking for particular researchable idea, and it seems to me like --

MR. BOLGER: Well, that whole field is a very difficult one that we are really struggling with, as you know, and the sanctions are not working. Now the motorcycle helmet laws are being repealed. If we did want to get mandatory seatbelt laws, how would we do it? We have gone to the states. We have talked. We have sent teams out and we end up with zero. That whole game is cooperative effort, certainly in the highway matters, but it even goes into railroad and now we have agreements there. We have agreements in search and rescue in the Coast Guard, et cetera. I think that is a fertile field because the success to date has not been good.

MR. HUMPHREYS: This was my point.

MR. BOLGER: Yes, and really, we could use a lot of help in that area.

MR. TAYLOR: I would comment on the federal-local thing, that I have been to at least three different local agencies recently and the problem really isn't, at least they don't perceive it as, a technical problem. It is a management problem. I have gone with my students and my students most recently asked in our own home town why they didn't participate

in some federal programs that we had just heard about the week before from PennDOT and the answer was, "Well, we avoid those at all costs whenever we can, because it is so much more work." For little projects it seems that technically they are never denied by the state or the federal government, but there is this long management problem that evolves eventually into giving up or the cost being much higher or the amount of work being required, and so even as high as New York City, you may remember at the ARBA meeting, which is certainly technically competent, at least we assume they have technical staffs that are very competent, so it is not really a matter of engineering. It is this management thing again and I don't know. Maybe our Institute of Public Administration, to use Penn State, is the one that ought to be involved in your program and I suspect that they are not familiar with your program. Our transportation institute is familiar with your programs, so perhaps we are lax there. I should go back to public administration in the state. You people should get into this program.

MR. BENNETT: I think what we are saying today is we perceive this as a transportation safety problem and a very real one.

MR. BOLGER: The comment there, over and over again the state government people say, "Well, gee, the amount of money we get from you, say, for highway safety, is peanuts compared to what we spend. Why should we go through this vast paperwork mill just to get that money? It is cheaper just to tell you to forget it and we will do our own thing." That is part of the problem. The carrot is too small, for one thing, to get the rabbit going the right direction. But that is not, I think, the way to go about it. It must be more of a cooperative effort, some more uniformity in our processes. For instance, on the highway matters, we try to work through the Governor's highway safety rep. That was a big effort a few years ago. I think it is kind of fizzling out. States are not organized that way and we somehow don't seem to see that. We go to see the man in Virginia. Is anybody here from Virginia? Mr. Walker is the state DOT Governor's rep and he is kind of a figurehead. He doesn't control anything. So we are talking to the wrong guy. I don't care who the state Director of Highways is. Their system is different. Now somehow we have to recognize that and accommodate, or at least all start moving towards uniform systems.

MR. DICESARE: Maybe the possibility exists for research in the area of, let us say, revenue sharing types of funding in safety for transportation for localities or states or whatever. In other words, instead of the paper process, allocate on some rational basis objective rule ---

MR. BOLGER: Because it is not modal. It is multi-modal, because we are working now with the states in all modes. Monies are flowing on grants to the railroad people in what, seven or eight states now?

MR. BENNETT: Oh, 12 or 15.

MR. BOLGER: 12? The pipeline looked at 49 states working with them. Highway, it is 50. Aviation, we are trying to load more back onto the state. Search and rescue is another area. So it is not just one mode. It is a multi-modal thing.

MR. DICESARE: Perhaps the investigation into a Departmental revenue sharing type of a situation where the states and the localities then could decide their own priorities in terms

of safety and then use the funds accordingly, either multi-modally or ---

MR. BOLGER: Of course, it ultimately may require legislation, so that is part of the thing we have to know.

MR. DICESARE: Well, feasibility could be at least determined through research, perhaps.

MR. E. MARGOLIN (American University): Mr. Bolger partially referred to a comment I was going to make. This is an inter-modal meeting, and we are talking now about the institutional questions and we have a growing development of state DOT's and relationship with state DOT's to local organizations. I am wondering if there has been sufficient research, if we are talking about inter-modal, whether or not the state DOT's have, I am aware of some of it, have grabbed hold of this and are working with the federal levels. For example, are they all going in their own direction? Do you still have different state institutions or local institutions that are concerned with that and never the twain shall meet? Now, we do have that development of state DOT's and I expect that will continue and there will be more coordination, but I also suspect that there is plenty of room for further analysis there to find out what is going on.

MR. BENNETT: I would like to echo that, sir, because in the railroad field we have had some difficulties with that traditionally on the state level. Some of the state activity has been done by a regulatory commission. Some is now done by a Department of Transportation. In our state program we had two competing applications from one state, where two agencies indicated they had the authority to enter into our program, so we, of course, sent it back to the state attorney general for an opinion as to which did have the authority, so it is a real problem.

MR. E. MARGOLIN: Yes, well, I did a little work for your organization in that connection, so I became conscious of that. Furthermore, we are involved right now at TRB,* we are taking another look at it, not just safety, but that is what brought it to mind as well as all of the discussion that was heard before.

MR. RABINS: Somewhat from a devil's advocate point of view of how we might get involved in the institutional relations in federal, state, and local, and based upon our previous experience of research with the universities, we have gotten involved with local and state institutional barriers that have to be overcome, but that was mostly in the domain of Paratransit or Taxi Share-a-Ride, Paratransit of Tennessee, you all know that study and the Taxi Share-a-Ride at Carnegie-Mellon University which involved getting into a hearing room with the Pennsylvania Public Utilities Commission and getting waivers to regulations on the group and fare fixing, fare adjustment.

But that was all a spin-off of research, of on-going research not in the institutional area, and here we are addressing a different problem: "Are there specific institutional problems that should be researched?" and I don't know, and our experience up to now has been that the involvement with the institutional barriers and institutional problems have been down the road from the basic research of problems that had to be coped with. Maybe it is appropriate to put the institutional problems up front in the safety domain. I don't know, is that research?

* Transportation Research Board.

MR. E. MARGOLIN: I don't know the answer either but still the thought is there and many of us have been concerned that we don't see what we think are the proper results that should be coming out.

MR. BOLGER: You don't see any efforts on the part of the federal government to resolve these matters or at least call for guidance or ---

MR. E. MARGOLIN: Well, that is a part of my question and I will admit that I am a little rusty on this, but I don't see where this is being done adequately.

MR. BOLGER: From my viewpoint in watching all of the safety matters going on in the administration, I would say it is very spotty. We keep getting into traps and we got into a trap on the railroad one. We had the requirements for personnel on the states they couldn't meet. They couldn't hire the people.

MR. E. MARGOLIN: I would like to respond to Mike's point here. It is not just at the level of the coordination, if you want to call it that, the federal level, and not just DOT, but also relationships with the state and local levels and many other jurisdictions.

MR. BOLGER: True.

MR. HAWTHORNE: I see this federal-state thing for the railroad industry, that an awful lot of what should be the federal role is to maintain the uniformity that is required to make interstate commerce possible at all. We went through this over and over in the environmental issue where in fact if you could comply in one state you couldn't comply in the next. Where does this uniformity come from? The same thing can happen in safety, with the fixed plan. Yes, you can comply to each state's laws, but with equipment that must move from one jurisdiction to the other and, in our case, between countries, Canada and Mexico, then if each state is defining its own safety rules, which has happened in some cases, how do you comply with them in interstate commerce? I think this is a role that I see needs some study as to which of those roles must be controlled at the federal level to make interstate commerce flow smoothly.

MR. BENNETT: I think it is a point of finding responsibilities for various levels of safety or elements of safety or however you want to call it.

MR. BOLGER: That is a very important point. That is why the various administrations were formed.

MR. RABINS: As a matter of fact, that fits in very closely with the global view of Congress and OMB on viewing university research funding that it should not go for local affairs of just one city or one state, but it should be addressed to problems of national importance. Because we are spending national taxpayer dollars, they are very sensitive to that issue.

MR. DICESARE: Perhaps Congress should be addressed directly in terms of what they perceive the research needs are rather than we, the university community, responding through other interpretations.

MR. RUDICH: You don't really expect an answer, do you?

MR. BENNETT: Well, I think they answer in many ways. By putting the priorities on the Department, is one way they

answer. They won't tell us the solution. Sometimes they will, but frequently they don't. They will tell us what they perceive to be the problem.

MR. BOLGER: Which is another problem and that is do we get up there and really sell our programs properly to Congress? We did a tremendous job in the space program with that, educating their staffs, et cetera. We spent an awful lot of time up there. Congressman Teague was the chairman of the Manned Spaceflight Subcommittee and he probably knew more about the program than most people who were involved, because he had exposure to all parts of it and continuously, but our committees who sit up there overviewing transportation are not give the same treatment, and I think when we get to the salesmanship part, we have got to get up there and sell it to them.

MR. DICESARE: As an example, perhaps there should be some Congressional representatives at this meeting, staff members or Congressmen possibly.

MR. BOLGER: That is a good thought.

MR. FOLEY: I get kind of a feeling listening to the discussions here that as far as the interaction between federal, state, and local, that each of the modes has a different problem, and that perhaps we can't find an answer to that if we try and talk about DOT's as a whole, because maybe I have got the wrong view of the railroad part of the program, but basically I don't see that as a local problem, but I certainly see highway as a local problem. I don't see aviation as a local problem and maybe not even a state problem, although state DOT's do have aviation departments and do regulate it, so I am kind of trying to find out where we go from here if that is in fact true.

MR. BENNETT: By "local" do you mean below the state level?

MR. FOLEY: Yes. I draw the distinction between state and local because of our program responsibility. It is another step down or up or whichever way you want to talk about it.

MR. BOLGER: Well, the ADAP program in aviation would be airport development, would be somewhat analogous to yours. I mean the local organization has to certify that airport. What do they do and how do they do it? Who do you talk to?

MR. FOLEY: Yes. Is that a safety element?

MR. BOLGER: Sure. Oh, yes.

MR. TAYLOR: I think I agree with Jim that there are many different state, local, and federal relationships in the different modes. I guess maybe the research that needs to be done is that; because they evolved at different times historically or because the programs really are different, are there things and arrangements that one mode has that the others can profit from? If there is not enough cross-looking, perhaps somebody needs to look at these different arrangements and try to determine why they are different, and if there can be some wording across the various modes of things that work and don't work and why.

MR. BENNETT: You raise a very good issue.

MR. HAWTHORNE: I see some very strong institutional

similarities, though. For example, if each state decided about highway truck safety features, and you have one state that says it must have underrunning protection which must be 24 to 30 inches above the ground and in the next state it must be 30 to 36 inches above the ground, that type of thing is in addition to interstate commerce because then the trucking company, corporation, has to make a decision which state don't I run in.

MR. RABINS: That is visible. But consider the problem in transportation of hazardous materials; different states have different regulations on how it is supposed to be marked inside the truck, or separated, or stacked, or for wheel axle loading. These impact directly on the institutional problems and that gets back to the fundamental research problem of how, in this particular example, hazardous material transportation should be regulated and, then, what is the coupling to the institutional concern?

MR. HAWTHORNE: This happens strongly in the nuclear fuel area.

MR. BENNETT: Maybe it is time to go on to the next subset of this panel discussion areas and that is turning from the governmental, intergovernmental relations, to government and industry relations, which is another part of the institutional problems that we perceive. I don't know if our industrial friends want to leave us while we have this discussion or not, but I think these are some very, very basic areas in the safety field that all of the modes are struggling with, how much control is required to achieve the desired level of safety? What has been the impact of safety standards on the industry? Have safety programs caused distortion in competition? What is the impact of different enforcement strategies? Have federal funds for safety technology reduced or increased industry research and development? I think there are a few very good questions that are involved in that. Would anyone like to start the discussion in regard to further defining those needs or approaches in tools that we might use to address some of those problems?

MR. RUDICH: I have a few remarks which I jotted down this morning and I am going to, if I may, amplify them by carrying Hank Wakeland's earlier remarks a step further.

MR. BENNETT: Good. I think that would be a good way to get that whole discussion started.

MR. RUDICH: Admiral Benkert this morning and, to a certain degree, Mr. Esposito touched on the problem of development, training, and motivation of new types of people to operate new types of equipment in new environments. This problem is obviously inter-modal, particularly to the extent that it is applicable on the aviation side of the transportation house, particularly in the area which I would like to address for just a couple of minutes, and that is the field of air traffic control. This is a field which has been essentially preempted by the federal government, although there are some non-federal air traffic control facilities, but I am using this only as an example because it does have inter-modal application.

Although the rate of air traffic control involved aircraft accidents, and I am zeroing in on the safety problem, and incidents, has not necessarily dramatically increased, that is the rate has not dramatically increased as measured against the ever-increasing numbers of flight operations within the system, there are a finite number that appear, at least to this observer, to make the current rate unacceptable. Now this is particularly

true in view of the types of errors being committed, and the working environment in which they are occurring. Parenthetically, they do not occur in high activity or high stress situations, by and large, as one might be led to believe by those viewers with alarm whose principal aim seems to be self-aggrandizement.

To the point that Mr. Wakeland made, I am quoting from the recommendation issued by the National Transportation Safety Board on the 31st of March of this year to the Administrator of the FAA, and I won't read it all. The NTSB has reviewed several recent ATC-related accidents and incidents and has determined that deficiencies in human performance were critical causal factors. The individual controller's susceptibility to error, despite sophisticated electronic equipment available to him, detracts from the overall benefits achievable to advanced automotation of the national airspace system. It then goes on to cite four near mid-air collisions.

Common to these occurrences were the facts that all sector or control positions were staffed by experienced controllers and the ATC facilities employed automated radar systems. There is your product side. The engineering side has already been taken care of, but the error still exists.

These circumstances suggest that the sophistication of equipment does not obviate the system's dependency on a high level of human performance, equipment design innovations that intended to unburden the controller from ancillary tasks. Accordingly, we believe the FAA must undertake a program to identify those aspects of controller performance which are most likely to result in potentially critical control errors and they recommend that the FAA conduct a comprehensive study of the human failure aspects of ATC system errors that have occurred since the automation program.

Organizations in the non-government sector in aviation have developed, or caused to be developed, devices, tests, and/or other methods for screening entrance to the field of "people-moving," which are aimed at identifying in advance and eliminating from the system those individuals whose traits, attitudes, reactions, and general working performance are indicative of lack of safety awareness. Those who were required to pass through this screen have evidence by their almost, if not absolute, accident-free record, of the efficacy of this type of personnel selection process. Unfortunately, this methodology has not been applied to the ATC field, which is also quite important in the people-moving process, and the results of this failure will be with us for many years to come.

They are represented by high costs of wasted training, liability of a govenment to lawsuits as an outgrowth of ATC-associated accidents, and the immeasurable cost to society in general, which results from this type of catastrophe. However, in my opinion and the opinion of my organization, there must be a beginning to the end. I must re-emphasize, my remarks are specifically directed in one area but may have application across the board.

One cannot accept the current situation and this may be the current situation as described here or in the new equipment that Admiral Benkert was talking about or the references that Mr. Esposito was making. One cannot accept the current situation and its previously stated prognosis as something that we must live with. A logical beginning would appear to be the identification of an acceptable psychological profile for prospective entrants

to the people moving field, whether it be an air traffic controller, a pilot, a mechanic, a railroad engineer, a truck driver, and obviously some of these are more adaptable for easy solution than others, and on the basis of appropriate selection of screening tests, the application of this process to the newcomers, and it appears to this observer, at least, that DOT research efforts could well be expended in this area, not only toward fighting the alligators, but draining the swamps as well.

MR. BENNETT: I think you raised a number of issues there, sir. First, to begin with, I think you reinforced what we were talking about before as one mechanism of identification of needs for the Department, and that is NTSB, and into this whole area, I think you are talking directly to our one subset here, what is the impact of different enforcement strategies, licensing, certification, incentives. Has there been sufficient work that can be translated into these people who are, what did you call them, "people movers"?

MR. RUDICH: Yes, people movers.

MR. BENNETT: People movers. Can we translate what has been done, and, is what has been done valid for the transportation mode? I suppose that is a basic question.

MR. RUDICH: Yes, that should be answered.

MR. BOLGER: There are institutional barriers, too, that are involved here when one is trying to screen individuals. We get into the rights matters, and it is very difficult to start probing into that side of the human element.

MR. RUDICH: I recognize the problem, Mr. Bolger. I have been involved with it for 33 years.

MR. BOLGER: Yes. You know we did it with spaceflight controllers very carefully.

MR. RUDICH: Yes.

MR. BOLGER: If they tried it with flight controllers in FAA, I think it would be helpful, unless we look at it carefully and find no way to get around this.

MR. RUDICH: I think it needs a hard look.

MR. BENNETT: I think there is another institutional barrier when you are talking about different kinds of employees, government employees versus state employees, versus private employees or contractor employees. There is a whole area that someone could look into.

MR. BOLGER: One way to get around it is to contract out the whole ATC system.

MR. RUDICH: And you wind up with a Post Office Department?

MR. BOLGER: Well, that is one way of getting around this barrier. You might get another barrier there. I don't know about that.

MR. BENNER: Your question relates to institutional problems and federal-industry relations. It is directly pertinent in the driver register and the ability of prospective employers to screen employees using the driver register. What

are the safety implications of that? Does anybody know?

MR. BOLGER: We cannot go into that system to examine whether a truck driver should be given a license or not or an airplane pilot given a license.

MR. BENNER: My question was what the safety consequences of that type of decision are.

MR. BOLGER: I think it is obvious. You know, we miss a lot of people we should have gotten hold of, because they are drunks and other kinds of people who showed up on their driver's license as problems. They get through because we can't look at that when we license them as a truck driver, and what have you.

MR. BOLGER: I would say that that is a very real problem and barriers ought to be looked at in that area.

MR. BENNETT: Are the barriers real or can they be gotten around?

MR. BOLGER: They are real. You cannot do it now. By legislation we can't do it. I have been to meetings on this where I was claiming that we should do this and had all kinds of rights people stand up and give me all kinds of hell about it and finally some lady was berating me like mad in Louisville at a meeting like this and I said, well, "Madam, if your young daughter was out driving a car and a drunk killed her, what would you think about it then, if we had been able to get rid of that guy or at least identify him, if we had been able to access that system?" But we can't do it.

MR. E. MARGOLIN: Putting aside, and you can't do this, the matter of striking a balance between the human factor, the social element, and so-called "economic efficiency," and I am really addressing myself to the second and third items in this list here. The second item, I assume initially refers to, when you talk about modal operations now, we are talking about federal or federal-industry. You try to develop "What is the cost of safety programs?" to a modal industry as such, then you add competition and then in the second phase you talk about the possible distortions of these costs and the costs can be measured in different ways, of course, and you have alluded to that in some of the language that you have here.

Is there satisfaction in the people who are involved in the safety research environment? That has not been my principal field but I have gotten involved with it over the years. Do we feel that we have done enough research to find out what the tradeoffs are? I know it is a very difficult area, but I am really coming back to my first statement. Do we know that we feel we have researched enough or tried to get better answers about the proper balance between the safety element, the human safety element, and what is related to that and so-called "economic efficiency" and the comparative result of impacts on competition?

MR. BENNETT: I think those are two very good issues and I don't really know if they are separable or not. What is the economic impact of the regulation on state or local governments, or on the private industry? What are the economic impacts inter-modally? I think of those in relationship to our hazardous materials regulations. Should we regulate all of the hazardous materials off the railroads, for example? That is going to have a very big economic impact. Those kinds of issues I think have not been seriously addressed.

MR. E. MARGOLIN: But when you are posing the questions as I tried to do, do you feel that there has not been adequate research in those areas?

MR. BENNETT: I don't think we know all of those answers at all, sir, and I think that is one of the reasons why we mention it.

MR. E. MARGOLIN: And wouldn't that deserve a fairly high priority in terms of the responsibilities that DOT has, for example?

MR. BENNETT: I would think so.

MR. E. MARGOLIN: I think yes, but I am posing the question.

MR. BOLGER: There is a case in point right now in the air brake system standards.

MR. E. MARGOLIN: That is a good example.

MR. BOLGER: But that is really the trucking industry.

MR. E. MARGOLIN: That is why I was trying to differentiate. We are not only talking about modally but inter-modally as well.

MR. BOLGER: Well, I understand, but we are really impacting the industry in a terrible way and we really didn't understand how far we could go or how far the impact would go in the system and really aside from that, whether the system is worth it or not. We don't really have the cost benefit information on that.

MR. RABINS: What is the role of the federal government in an area such as the anti-skid devices, the 121 system? How far can the government go before industry starts flapping their arms wildly and saying, "Whoa, that is going to cost us too much money to obey those regulations"? Where is that threshold? What is the role of the government in pursuing research of that sort or trying to instigate research in the industry itself?

MR. E. MARGOLIN: We have very loosely referred to this, I have, in any event, called economic cost of safety. What do we know about it? I know efforts have been made in this area, but what I wasn't sure of was the extent and how close we were to any kind of solution, if there is one.

MR. RUSSELL: Well, it just seems to me that if you are going to go into these areas, you can only take the industry's word for it, the impact.

MR. RABINS: Yes. That is where we are right now.

MR. RUSSELL: It seems that there is a need.

MR. RABINS: I think that is one of the roles of the universities, to contribute positions on available solutions. Then it becomes a political issue between the Congressional and executive branches to pursue regulations. I think the university's role is to demonstrate, for example, in the 121 system that it is possible to engineer such a system and get it to work, and demonstrate that it does work. I think that is a role of the university, a very practical role.

MR. HAWTHORNE: I have a couple of things. The regulator, as I see it, is somewhat bound by the federal law and I think that perhaps thought needs to be given towards that law-making process that allows laws to go into effect that require the regulator to issue regulations. They do not require, as in the Railroad Safety Act, I think the wording there, to use "relevant safety data," which didn't exist, and the relevant data on the railroad safety problems did not exist, so they had no data.

MR. RABINS: There are many examples like that. There are Congressional hearings going on right now on environmental controls of emissions from automobiles and there is a non-existent data base on not only what the emissions are but how it affects us. There is a need for basic research that will permit the regulations to be drafted intelligibly. Again, that is a role, I think, for the universities.

MR. HAWTHORNE: Speaking for myself, working in industry, the regulations at times are needed. I think industry recognizes the need for industry self-regulation, at least as far as any changes in equipment, and regulations are needed. Yet, the total thrust of regulations to date has been directed toward the prevention of train accidents. Prevention of train accidents is only the very, very tip of the iceberg on the personal injury and fatality issues. Even in train operations, it is only four percent of fatalities and 19 percent of the injuries, so you really can't hope to have the personal safety problem solved there and yet we will tend to shy away from this. What do you do with these man problems? What do you do with the back injury reaching over to pick up the gloves? You know, there is a range of these things that ranges from that to a man that, as was said this morning, has always done the job wrong, and the probabilities finally catch up to him.

I think that we have got to start facing that issue pretty soon, or else we are not going to ever regulate the safety problems. We are regulating the economic problem, not a safety problem.

MR. MONROE (Aircraft Owners and Pilots Association): I read in the Federal Register the other day that the Secretary had promulgated a new policy of requiring some sort of impact analysis of the costs and so on of notices of proposed rule-making and I wonder if this does not open up a whole new area of investigation. We were talking a moment ago about the cost of regulation. One of my friends from one of the aircraft factories here a few years ago became a little upset over the cost of certifying aircraft and went through an exercise with a Chevrolet at that time and found out that if it went through the same sort of a process that his Cessna 172 did, that the Chevrolet would cost something on the order of about $66,000. Now, how valid that study was or what the results of it were or what credence can be put to it, I haven't the faintest notion, but it does seem to me like there are a great many costs in this proposition which become impacts and which do justify some sort of investigation or research to ascertain what they are.

MR. BENNETT: I would commend to all of you that statement of the Secretary's that I think is titled "Regulatory Reform" and it addresses a number of these issues. We in the Department are required to assess the economic impact of proposed regulatory and grant policies. We are also to provide an opportunity for a periodic review of our grant policies and regulations. There were three elements of it. But that does immediately put on all elements of the Department, those responsibilities, and we will of course undertake them, starting May 1st. I think the issue

that we are raising here is what is the best and proper way to make those economic analyses, particularly of safety issues, which can be very difficult, as you point out, and I think this is an area where we are pointing out an area where I think we may need help in two areas. One, how are we doing it now? Is that an effective way to do it and how should we do it better?

MR. GRIMALDI: I am not sure we are ready to leave this, but I just want to make sure I get this in before we leave it. The agency-industry interface and the integral problems that are connected with that particular difficulty, the major issue, I think, which focuses around all of the points that we have been talking about so far is: "What indeed are we looking for?" How do we, first, measure the performance the agencies are expected to deliver? Before we can talk about that, what indeed are the agencies expected to do? For example, if you are going to be required, as you are now, to do cost effectiveness studies on the various steps you are going to take to improve safety, the inference is that there is a limit beyond which you dare not go in order to achieve safety and yet in the western world the notion is that every life is precious and that safety should be concerned with accident prevention, which means literally a zero fatality rate, in fact, a zero disabling injury rate, and if you are caught on the horns of this particular dilemma, you are going to be literally pinned to the wall time after time.

One of the issues that Congress must understand is that it is creating a problem, just for the implementation of safety along the lines that we are discussing it this afternoon. Now, research can be, I think, used to begin to find the answers, but this is a very difficult problem to research. It will be many, many years before we begin to find precisely what it is we are talking about when we speak of safety and how we can measure the effectiveness of the agencies that have the responsibility for achieving safety.

In the years that will progress before we get to the point where we have the answers, it is probable that some agency head or some Senator Proxmire or his successor will say that a lot of what has been going on in here is nonsense research because what we are doing is exploring if we talk about these particular factors. We must understand this amongst ourselves and in fact communicate this to the people who are judging us, because it isn't until that happens that we can begin to do the kinds of things that we want to do.

MR. BENNETT: I think you raise all of the issues that we are going to be wrestling with as we implement that policy statement

MR. HAWTHORNE: We have seen recently that we are talking about economic justification, that it needs to be thought of a little bit more deeply. I think that many of us have been guilty of presenting our economic justifications improperly, because in a business such as mine, we tend to look at this X million dollars, say, a $20 million accident category of one railroad, and we tend to apply that as if that comes out of the net revenues of that corporation, where in fact it doesn't. It comes out of the gross and there is a much larger number to make up that $20 million, depending on your gross to net ratio, and this tends to be overlooked in most of the justifications we have done of safety programs, that really there is a lot bigger chunk to be gained, and if we go at it properly, we are really gaining a chunk that has to be made up out of gross revenues. I don't know if I have put that in quite the right terms, but the safety

dollar is really much larger than it appears to be or should be.

MR. BOLGER: Of course, that cost benefit analysis question has come up with the Secretary in some of these regulations. In fact, one proposal to him was that it is one to 1.2. Therefore, it is better than one -- he said, "Well, who said that is the right ratio?" Well, as a matter of fact, there wasn't any answer. But it is a whole area that has to be looked at. What is the right ratio? Maybe that is okay for a truck, but is it okay for a school bus? So it opened up a whole new door for which we all sat there with no answer.

MS. MISCH (George Washington University): Picking up on what Professor Grimaldi was saying, when we talk about cost benefit and safety issues in transportation, we are hitting values and it is going to be controversial. There are the elements that he mentioned, you know, how much money is too much? How much money is enough? How much injury is too much? How much injury is okay? Then we also have this other value in our country that the individual really has a right to do what he wants to. We have had this so strongly for so long that it took many years after the automobile was invented and then became a safety problem on our highways to even get to a reasonable speed limit on a national basis. The death tolls were tremendous. People were screaming about the Vietnamese War, how many Americans were dying, and we had more dying on our highways. The "independence" factor makes this truly one of the hairiest areas to deal with in terms of what DOT is going to do. Maybe a research issue that might be of value to you, but I don't know if it is too hot to handle, would be to take a look at the people in this system that is our country and do some investigation into what the values are.

For example, you brought up what the Secretary said about the ratio in the school bus versus the truck and what you could tolerate. It is not only that. It is also who in the country thinks that "X" amount of money should be spent. You have to get the dollar amounts. Who thinks very little? What are the opinions in different segments? The segments can be industry. They can be parents of children. They can be local government people. I throw it down as a challenge. Do you think you could all really fund some research like that or not?

MR. BENNETT: Well, I throw it back to you. I think that is the burden and responsibility and opportunity that the Department has in its various safety matters and that we need to live with every day. We are constantly being condemned, criticized, complimented on all of those various issues, and the arguments are there when we undertake training, when we undertake voluntary programs, when we undertake regulations, or when we ask for appropriations. I think this section is almost the guts of the Department's safety issue and I think we in the Department, at least, in my element of it, are saying we need help on all of those very controversial hot issues.

MR. BOLGER: The questions you ask, though, are going right to an area which is very important and that is: "Could we change the attitude of the public by changing the rule-making process to more involve the public somehow?" I don't know how. Is there a way of doing this?

MR. RABINS: Witness the seatbelt interlock fiasco and what happened there when our values conflicted with economics, not to mention political pragmatics. It is not just values, it involves a whole set of issues and if we are going to initiate

change, it has got to be through a complex mix of recognizing the pressure on our pocketbook, on our minds, our hearts, and the pragmatics of the political system that we have to work with and then getting research to contribute solutions that will make it all work together.

MS. MISCH: Yes, and for that you have to know what the attitudes are and then what is playing into them.

MR. RABINS: Yes.

MS. MISCH: What is forming them.

MR. RABINS: You know, the pure technological solution of a seatbelt interlock, for example, obviously is not going to work unless you understand all of the interactions of the values, of the political pragmatics, of the economics, and of getting the technological proposed solutions to work in the context of all of the pressures. Your point is eloquent, Marian.

MR. BOLGER: If we had that methodology, we would know what to do about the air bag.

MR. BENNER: As a practical matter, do you have an historical record anywhere of those changes that have been successfully engineered or brought about in the safety area? In other words, what can we learn from what we have succeeded in? Do you have that?

MR. RABINS: I would doubt it.

MR. BENNETT: I would guess no.

MR. BOLGER: They slip things in here that people don't know about, like the collapsible steering wheel. Nobody knew about that, really, did they, until it was there? But what about the $300 air bag? What are they going to say?

MR. RABINS: You would be surprised by the irate letters that are coming in to the Secretary now about not only the seatbelt but also the air bag.

MR. BENNER: Changes have occurred in the past. What can we learn from the way that change was brought about?

MR. BENNETT: To answer your first question, I don't think we have that, other than the experience of man and that is all.

MR. GRIMALDI: There may be a partial answer to that question. A man named Peltzman, he is a member of the faculty at the University of Chicago, writing in the Journal of Political Economy in the August, 1975 issue, volume 83, number 4, has done a study on the effectiveness of safety regulations and the ways they are not effective. In fact, he says they have increased the incidence of pedestrian fatality. Now, you may question the quality of the research because it is a mathematical model that they were using, but it is an interesting study. It is the first one that I have seen that attempts to get at the particular point that you are making.

MR. J. MARGOLIN: In human nature, you can't quite use that kind of design because for example, your dual brake system was put in very quickly and very easily. Nobody made any big fuss over the fact that there was an increased economic cost for it. It was put in and it may or may not have been useful. That

is a whole other set of effects, but you really have to have a another confrontation with consequent costs before you begin to get the cost in public value that Marian was speaking of, so you really have got two separate bags here, something that has happened and that may produce an effect or may not produce an effect, despite the cost move. Go right ahead and the public will not appreciate what you have done. Withhold it, as with the air bag, which may or may not be used, then you have got a major issue with the Department of Transportation withholding safety from millions of people and thereby officially producing many deaths.

You haven't got a controlled situation of putting this kind of research on the table.

MR. E. MARGOLIN: I am just going to muddy the water a little bit. Maybe that is a good way to wind this up here. Several years ago I participated in a conference at Brookings. The title of the conference, as many of you know, was "The Value of Human Life," and it wound up in a wild controversy. That is germane, though, in a way, to what we are talking about here.

MR. BENNETT: We have one more area to go over and that is the area of federal-public relations. As I read these issues, they sound very much like some of the things we have been talking about before. Has the representation of public interest been productive or counter-productive in setting safety standards? Even more basic than that, have we adequately defined what the public interest is or who represents the public interest? I think those are issues that we wrestle with every day. The second issue stated here, how can the public's willingness to accept higher risk and lower cost be determined? What conclusions can be drawn from the public's apparent willingness to accept different risk rates in different transportation modes? Are institutional factors present? These are some areas that we have talked about before as we talked about federal-industry relationships and these are even more basic. Do we have any further comments as far as setting or defining further needs or approaches that might be effective in these areas? Who represents the public interest?

MR. BOLGER: That is a good question.

MR. DICESARE: I think this goes back to the idea of measurement of attitudes; and further to the use of those attitudinal measurements to predict actions that people will take. There hasn't been a very large correlation between the measurement of attitudes and what people will do as far as I can see, so sometimes just the measurement of the attitude doesn't answer your question. When a person goes to the ballot box they may vote just the opposite from the attitude.

MR. BENNETT: These are issues that Congress will frequently set on us because they are very good, broad issues, that we must consider the public interest and I think that term probably has been defined in a number of court cases but it still presents, I think, to us in the Department, a practical problem of understanding the public interest. Do we have the right mechanisms to get the public interest expressed to us and do we really get more than a part of the public interest? Do we really get all of the public, in our, for example, rule-making proceedings? A number of groups are well organized. The industry groups usually are. The university community may be well organized. The employee groups are well organized. Is that the total public interest? I would just raise that as a rhetorical question.

MS. MISCH: I think a research issue here is probably critical. In some way university research is the best adapted to do this because you are not tied to one mode or to particular consumer groups. It is taking a look at consumer groups but not necessarily as political animals. You were saying as you went over the issue, "Do we all have representation?" but, of course, what we have is vocal representation of the organized.

What we really need to get at is the great unorganized in this country, the people who do not particularly like to go to political meetings and say, "I want it this way," or "I want it that way," the people who, even if they do go, don't talk out. I do think we need to measure their attitudes in order to help us try to predict behavior. I would agree with the gentleman who said that often attitude studies turn out to seem very invalid. The problem is that people lie. Would you like the subway? "Yes." They would really like the subway so the streets are clear for their own car.

However, I think there are ways around that. It depends on the context in which you measure attitudes. If you do it by a fairly superficial survey, you are going to get poor results. People are smart. They sense what you are doing. They realize they can use the survey, too, in order to get things done that they would like to have done but that they don't necessarily want to use. So, I guess I am pleading for a great deal more of in-depth attitude study and very much more of the usually untapped population segment.

MR. BENNETT: I wouldn't state that there is a Departmental policy in regard to consumer involvement in rule-making, for example, that the Department should make every effort to involve consumers in the rule-making activities or any of their activities. I know in my particular mode it has been a problem as to how you do that. Who is the consumer as far as railroad safety services are concerned in that area? I think here again we have addressed an area we perceive as a definite need. How we get further into that need is what we are here to discuss, I think.

MR. J. MARGOLIN: To pick up where Dr. Misch left off, I think part of the problem is that the government's policy has been a relatively passive one with regard to what the consumer feels. Now, I know that over the past few months or so, or maybe a little longer, there has been a much more aggressive policy of publicizing consumer panels, of going out to the field and letting people know you are in Chicago or Des Moines and that sort of thing, but, nevertheless, even when you go out in the field, it is basically the same organized groups who show up. I think what I heard Marian asking for was a somewhat more agressive process of segmenting or stratifying your population, finding out a great deal about what people in particular levels of life do feel and then having a tool which tells you what kinds of complex programs you have to build because the needs of people in the ghetto are obviously different from those way out in suburbia. Their attitudes are different. What they will do about not getting or getting something is vastly different, and without, not only the segmenting or stratification, but also realizing what the implications would be of getting one rather than the other, you really can't make any projections.

For example, if you ran an executive bus from the Burning Tree Country Club to downtown and put that into the total

expenses for Metro, and this became public information, one would hear about it in terms of the service in Takoma Park or in Southeast Washington.

The questions then would need to be a balancing of "what if something like this were done?" addressed to a number of other people who may be competing for a limited resource, and not on the basis of a survey or a standardized survey or anything like that, but really on interaction with the people and not where you sit as a government person asking and listening to a prepared statement, but where you have a chance to hear somebody else in that same community shoot down the ideas. For example, just to take one case, we ran a panel with handicapped people a couple of months ago, and listened to almost an hour and a half of pleading for changes in public transportation and sidewalks and everything else, involving just impossible costs so that every possible public vehicle could be used by the handicapped.

Then some people who had been quiet who were invited into the discussion sounded off quite to the contrary. No, they wanted their own transportation. They didn't want to be in public transportation. They were scared of public transportation, and a point of view that never would have been received if you waited for them to come to you was heard, so I guess we simply have to do more listening.

MR. BENNETT: Well, I think you raise a couple of issues there. There are some safety issues or transportation issues where you will get a large involvement without doing anything affirmatively. There are other issues where we need techniques and tools to go out and affirmatively get the response and I guess our question to you would be what are those techniques and what are those tools and how effective are they and in what kind of situations should they be used?

MR. J. MARGOLIN: Well, I mentioned one which was that of really stratifying your population and then not asking for volunteers. Washington Gas Light is a company that we visit here in town. We asked them for certain types of people and asked them if they would release those people for two or three hours to talk with us. We sort of put our finger on what kind of individual and what kind of group we wanted and came away with a much better sampling than the public.

MR. BENNETT: I guess the issue I want to raise with you is how do we do that kind of thing for the transportation of radioactive material by truck, highway, or airplane? You know, your consumer involvement is not as obvious. There the effect can be just as obvious, but we have to work a little harder at getting consumer involvement in those kind of activities and how do we do it?

MR. J. MARGOLIN: You are right. That is the one harder to get.

MR. BERKHOUT: How do you expect consumers to be entitled to an opinion on the transportation of radioactive substances? What on earth do they know about it?

MR. BENNETT: They are going to be affected by it and certainly as citizens that we are trying to protect, they should have a voice in that protection. I think that is the whole philosophy behind consumer involvement. This could very well affect them one way or another.

MR. BERKHOUT: But not in any way that they can think about constructively. They are in no position to assess the relative risks of different modes of transportation for that kind of stuff. They can tell us what magazine article they read most recently.

MR. BENNETT: Then you are saying they are not very knowledgeable and I think that is a handicap that we have to accept on that level.

MR. HAWTHORNE: I think on the other hand that nobody would be in a position to dictate that risk to them either. Even though they are not knowledgeable, nobody should be in a position to dictate that risk to them.

MR. BENNETT: Are they willing, for example, would the federal public be willing to pay for new facilities or removal of facilities to alleviate a risk?

MS. FREE (Center for Auto Safety): As a member of the public, I have been very insulted by your comment that I don't know enough to respond to anything. We have found that different agencies within DOT have different types of responses to public involvement. For instance, NHTSA is much more responsive than FHWA. NHTSA has a hotline. It publishes its rules for public comment, where FHWA tends to publish only the final rules and did not ask for public comment, and we find this to be a tremendous handicap because we would like, as a public interest group, to have some input. We feel that that input is valuable and we would like to have that input before the rule is made, not after the rule is made.

MR. BURNS: For about four or five years when I had line responsibility for hazardous materials I toured the country on a continuing basis with several themes, one of which was to point out to consumer groups and other types that we would appreciate having more input into our regulations, whether it be an advance notice or a notice. Now, we very seldom have received in the past, and I don't see any evidence of any enlarged interest at the present time, any input into the regulations, so the regulator is at a basic disadvantage.

The regulatory reform philosophy that Mr. Coleman has put out into the Federal Register,* will make, for the first time in the Department of Transportation, some major changes in the manner in which regulations will be proposed, the manner in which we will get input from consumer groups or individual consumer, and the manner in which the Department will defend its position in terms of cost effectiveness and cost benefit analysis. There will be quite a drastic change in the whole rule-making concept, but this leads me to an obvious question. We are all consumers and I don't remember, if ever, seeing any comments submitted into the docket by universities. I would pose the question, since they do have some knowledge, as we all do, about certain subjects, why they have not, as a university, entered their comments into the docket?

MR. BENNETT: I think Bill's comments point out the limit of the regulator in this area and why we have posed this as an issue. It is a real issue as far as we are concerned and we identify this as a real need for help, if you will.

MS. SIMPICH: I would like to back up Mr. Burns. I have read practically the whole docket for the recent elderly and

* Federal Register, Vol. 41, No. 75, Apr. 16, 1976, Notice 76-5.

handicapped proposed rule and I think that only three universities responded.

MR. BENNETT: Maybe that brings up another element of the use of university research, whether or not it is funded by the Department or university expertise.

MR. HESS (University of Michigan): Maybe we could have a clarification of what do they mean by "university response"? Certainly the university itself is not going to respond. No faculty member usually presumes to speak for his university, so perhaps they are simply speaking for themselves.

MS. SIMPICH: The way the docket is set up, you just tab who wrote. We got something from Carnegie-Mellon. We got something from the engineering department at the University of Virginia and one more, maybe one more. Now, I don't know who was writing for them but it didn't matter to UMTA in receiving comments from the public.

MR. HESS: How many people on faculties wrote on their own stationery?

MS. SIMPICH: They wrote on university stationery.

MR. HESS: These three wrote on it but I don't think you can make the converse decision, then, that university faculties are not responding to public issues.

MS. SIMPICH: That is a good point.

MR. BENNETT: Then maybe they are responding as individuals. Is the university a consumer also?

MR. BURNS: I would like to add on to the statement made. Let us take, for example, the transportation of radioactive materials in passenger planes. It is quite a controversial subject which affects each of us who travel on a passenger flight. It would seem to me as we survey the docket, as we do in great detail, we would have noticed a lot of John Doe's, Ph.D., who may not necessarily have been a faculty member, but it would have been indicative of the fact that perhaps faculty members were responding. We don't see many of those either.

MR. MONROE (Aircraft Owners and Pilots): It occurs to me that responding to rule-making can become a sort of a labor of love. I happen to be responsible for the assigning of the responses inside our organization for pieces of rule-making. Just for the FAA alone in a year, it will come out with an average of more than one per week. Those are pure rule-making deals. I am not referring to all of the air space changes and the instrument approach procedure changes and all of the other kinds of things which are possibly rule-making and possibly non-rule-making but almost have the effect of being rules.

Then you go further. I suppose that with the various other organizations, the Federal Communications Commission comes up with innumerable proposals of one sort or another. Many of them are related to aviation or transportation in some fashion or other. I presume the other agencies which I don't watch particularly in the DOT, come up with similar amounts at one time or another so that anybody who wants to take on this task of responding to rule-making has invited themselves one large chore.

MR. BENNETT: Well, sir, I think you have identified a problem for consumers and for the government in this area. Given the great activity of the government in this area, how do we accommodate all of the interests and the needs for comments? It is no small problem.

MR. BERKHOUT: I think you are never going to be able to contact even a small fraction of one percent of all of those who are going to be effected or annoyed by a rule in your pre-rulemaking correspondence with them. The first most people hear about a rule is when they are told they are violating it after it has been promulgated. I don't see how you are going to get around that because most people just don't have the time to pay attention to all of the brochures you are sending out announcing your rule-making function. It is not the public, but a very special self-selective public that keeps abreast of those things. You can satisfy them and still annoy the 99.999 percent of everybody else who doesn't keep up with it.

MR. RABINS: We have an interesting parallel to this question involving universities and the Department of Transportation. When a highway is planned through a town, as Judith Connor mentioned this morning, which divides the community, how do you get the participants that are going to be affected by that decision involved in the decision-making, in the review of the decision, and in the planning? There has been research funded on this basic question. Professor Schuster at Drexel ran a conference this past January on consumer participation in transportation planning which was widely attended. This was the first step that was made in trying to get consumers involved in the planning process. That is the same issue we are facing here -- of getting consumers involved in the rule-making process. What is important now isn't so much getting large segments of the public involved, as it is in initiating appropriate research for getting consumers involved in safety regulation-making so that you get the public to react before the regulation is cast in concrete.

MR. BERKHOUT: One of the big pitfalls in doing something like that is that your techniques for contacting the public bias the results and hence I look at who responded, how they are notified. All of these things have a substantial influence on the kind of results you are going to get.

MR. BENNETT: Of course, that is why we are saying we would like to have a better technique and method.

MR. BERKHOUT: The only way you are going to get a true result is with an honest random sampling where you take people from a sample of truly everyone, you take people at random and then go and catch them with a net and insist on them giving you an answer before you let them go, because if you allow the public to self select themselves in any way, that is going to bias the sample that you get.

MR. FOLEY: There is another way and I think your point on examining the process is very true. As you know, the safety administration does go through a rather involved process in setting their standards and implementing them and they have lost several battles in Congress. The seatbelts is one, the incentives for seatbelts. The helmet law is another one and the 121 brake rule is now under pressure. They have gone through these processes in a very formalized and equal way.

The answer is that you get results when you do

something, when they finally promulgated the rules. Then the fireworks started. That is the same thing that happens in our highway programs. You can tell the city for years that this is where the freeway is going to go. The day that you pass the condemnation ordinance, then all of the fireworks start and all of the people that have been sitting on that line for 20 or 30 years suddenly realize that, "By golly, that is my house, and I don't like it," and away we go.

MR. HUMPHREYS: I was going to offer a tongue-in-cheek suggestion just before this because we have just had a very specific instance. Two years ago we attempted to get some things changed because of safety aspects and we couldn't get anyone in the community interested. It has gone to land acquisition now and all of a sudden there are a bunch interested because they went out and drove stakes. I submit that what maybe we ought to do is to drive a stake in everybody's yard in the community and they would suddenly get interested and attend the public hearing. Put a red flag on it.

MR. HEIGHTCHEW: This might be a closely related suggestion, although it probably lacks the glamor to be really popular. Not too long ago I was involved on the citizen end of citizen partipation in a transportation, though not safety related improvement, and the citizens that lived near me, near a highway improvement, took an aggressive approach themselves rather than an aggressive approach on the part of the professionals. They achieved the result that they wanted in terms of highway improvement because they had the force and the energy and they provided what was needed. It was the first time I had ever heard applause at a public hearing. That leads me to the inescapable conclusion that a belief in the fact that consumers can have a positive effect on government is the critical issue. It is not the case that professionals can go out when people believe that they are not going to have an impact and somehow turn the thing around so that they get the right answers from the right people. It seems to me that the solution is to start very early with civic leadership classes in schools. Try to instill upon people, especially kids, the fact that the consumer movement can be positive as well as negative.

MR. BENNETT: Actually we are now setting the stage for panel No. 2 tomorrow, "Planning and Goal-Setting for Transportation Safety." I think we are getting our thought processes worked into the transfer tomorrow morning, but let us have a couple more comments.

MR. RUDICH: Just one brief one concerning Mr. Heightchew's comments. In the Mt. Vernon magisterial planning district of Fairfax County, the County of Fairfax came out with a proposed and very long-overdue revision to the five-year master plan. The citizens, through the medium of their citizen's association, and the district council of citizen's association, rose up in arms at the inadequacy of the county's plan and the Council of Citizen's Associations, represented by about five other people and myself, drafted and published a master plan for the entire planning district, a document 3/4 of an inch thick. It can be done.

MR. BENNETT: Well, I think we have two good examples here of consumer involvement that was successful. Perhaps we need those kinds of things documented and some mechanism for circulation of them so that people know it can be effective.

MR. J. MARGOLIN: I wonder if we are not talking about

a number of different things that may indeed require different kinds of approaches to obtain them. We have been talking about consumer attitudes and consumer values and that sort of thing and we are ranging all the way from whose ox is gored, whose backyard I-66 is going through, to a question which is not quite as likely to stimulate attention, such as the fact that the City of Laurel has very inadequate transportation but no way of really mobilizing a positive program to do something about getting some. The reason is that this is now a positive act rather than a negative one in taking away somebody's property and building a road through it.

The third element is what the consumer or what the public feels. I find this in the fact that Buick, for example, is now making great hay out of a slogan called "the free spirit." Now, that slogan is really tapping something. It has good public response. It concerns all of the things that we are talking about in terms of getting automobiles built in a way that will save energy and cut down on pollution and congestion and so forth and that slogan is going counter to all of the socially beneficial things that we are asking for, and yet it seems to reflect the consumer or the public's interest.

MR. HUMPHREYS: Good point.

MR. J. MARGOLIN: So I submit that we are really talking about, when we talk about what the consumer wants or thinks, we are talking about a number of different things.

MR. TAYLOR: There are things that consumer groups can do and that has been shown, but to assume that those are automatically good somehow bothers me a little bit. If they stopped, as they did in my home town, and bypassed, then perhaps that is good for the community and perhaps that is what the community wanted, but for every traveler that goes through my home town who is not involved in any citizen input or any of the proposals for citizen input that I have heard, they would probably all vote for the bypass. Now, I don't know how you weight their desires, or my desires to pass through Laurel or whatever the other town is, against the people who live there and are stopping the bypass, but just what you have done is what has happened. We have taken it from a small group of professionals, and that doesn't mean they are necessarily right, and we have gotten out to a somewhat larger, still far less than one percent, group that is taking over the decision-making and I don't know that that is inherently an improvement, nor do I know that we have representation of people other than the people affected. That is going to be a problem, I think.

MR. BENNETT: Well, I think the issue you raise is how do we evaluate this consumer involvement once we get it.

MR. TAYLOR: Right.

MR. BENNETT: That is another good issue. I think it is probably time, then, to call an end to this first panel. First, I want to give anyone an opportunity to speak who wishes to identify some specific needs or approaches that touch upon these insititutional problems. Does anyone have some of those that you would like to share, either institutional research needs or institutional research approaches that we have identified or we should be thinking of?

MR. FOLEY: You asked one question and that is who represents the public, and it seems to me that the public employees,

you and I, whether we be city employees, state employees, federal employees, do in effect in many instances, represent the public, trying to answer the question of the guy who wants the bypass rather than the one who lives in town. I think the question that needs to be tackled a little bit is how best can we do that, but I think it is our responsibility.

MR. BENNETT: I think in the bottom line it certainly is. That is what we are paid for. But we certainly need a lot of help and I think that is what we are saying too, how can we do our job better.

MR. MONROE: I am afraid I will have to enter my own dissent. The government employee functions as a result of law, a law written by a national legislator who is elected. I think you can logically draw a conclusion that legislators have not been fully representing the public interest in view of the growth of special interest organizations, associations, other types of activities, particularly their fantastic growth since in the early thirties to the point where now one of the big businesses in Washington is association work and all of these people are engaged in representing their constituency of the public, trying to redress or improve what the law-makers set down in law and what the government official as a consequence attempts to administrate and regulate.

So to say that the government employee is the representative of the public interest, I think, is only a part statement of the truth, and I think it comes around to both. Of course, there is also that great unwashed who don't belong to anything who probably don't get represented by anybody.

MR. BENNETT: Well, I won't try and summarize all of our discussion today, but I would like to say I think we had a good discussion of some overview principles, problems, and approaches of the University Research Program and some attempt to identify needs and approaches in the area of clarifying research needs of institutional factors. I appreciate your help, comments, concerns, very much.

EVENING SESSION

MR. BOLGER: Our speaker tonight is the Honorable Webster Danny Todd, Chairman of the National Transportation Safety Board. He was nominated for a five-year term as member of the Board by President Ford, took this position in February the 9th of this year and was named by the President to serve as Chairman of the Board.

Prior to coming to the Safety Board, Mr. Todd served as Inspector-General of Foreign Assistance in the Department of State as an Assistant Secretary. He also served a two-year term as an Assemblyman in the New Jersey legislature. He came to Washington in '69 as special assistant to the Chairman of the CAB. He held this position for two years and then left to become Executive Director of the White House Conference on Aging. Early in '73 he became Deputy Special Assistant to the President. Now prior to these rather high-level positions in the government, he had quite a background in aviation. He was associated with a commuter airline and aviation fixed base corporation in New Jersey. He was the owner and president. That is a good association. During this period he was also a partner in the General Aviation Engineering Company of Somerville, New Jersey, and President of the Princeton Air Research Park Company of New Jersey.

He graduated from Princeton and later attended Stanford Law School. Now, one thing I left out was the fact that he is also a pilot, an aircraft pilot of some experience. I introduce the Chairman of the NTSB, Danny Todd.

THE HONORABLE WEBSTER TODD, CHAIRMAN, NATIONAL TRANSPORTATION SAFETY BOARD ADDRESSING THE EVENING SESSION

PRIORITIES IN TRANSPORTATION RESEARCH

Honorable Webster B. Todd, Jr., Chairman
National Transportation Safety Board

Phil, thank you very much. I had a very long prepared text to deliver tonight and I was told that this was an extremely serious conference and I have been surrounded by these guys at this table and we haven't had a straight word all night and since Mr. Bolger has told a story about me, I will have to tell him one that is one of my favorite old political stories and involves William Howard Taft. William Howard Taft was a man of prominence at the same time that a fellow by the name of Chauncey M. DePugh was of equal prominence and a noted orator, and Chauncey M. DePugh never spoke for less than 45 minutes; he was given the marvelous assignment of introducing President Taft at a meeting in Chicago and Mr. DePugh got up and he spoke for an hour and a half introducing the President of the United States and he finally concluded his introduction by saying, "And ladies and gentlemen, I give you a man pregnant with responsibility, William Howard Taft."

Well now, if you have ever seen a picture of President Taft, he was rather a large fellow and he approached the podium patting his stomach like this and he said, "Ladies and gentlemen, if it is a boy I will call him Uncle Sam, and if it is a girl I will call it Miss Columbia, and if it is just hot air, I will call it Chauncey M. DePugh."

I asked my staff what kind of a meeting this was going to be and what I should be prepared to say and I got a note back that said "It is university research workers being addressed by DOT groups who will probably later fund their research," one. Two, "Half of the audience is already under contract to DOT and the other half would like to be." Now, I want to know which is which before I go any further at all.

Seriously, I am delighted to be here because in having a chance to wander around a little bit before dinner and the few serious moments that we had at dinner, it is clear that one of the things that is being addressed here in this type of a symposium, is one of the major problems that faces not only safety, but any area where there are more than one persuasion and practice and discipline involved, and that is the need to communicate, the need to exchange, the need to just get to know one another and know what is on other people's minds and what the various potential approaches are to a particular problem area. If you lose that or you don't have that in the first place, you haven't got anything.

The NTSB, what do we have to do with university research? Well, if Henry were speaking, and he will have that opportunity tomorrow, he would give you an extremely disciplined and scholarly discussion of our role and what we do. I have only been there since February and I haven't found where the money is yet. As soon as I do that I can properly start functioning as chairman, but we are probably the indirect trigger to a large number of some of the RFP's for research that come out of the modal administrations and those involved in transportation, because, as you know, we are really in the research business ourselves. The main difference between us is that we deal with applied research, and trying to figure out why something happened as opposed to dealing with pure research and looking at what we can make happen or what ought to happen in a particular area.

I think some of the things that we do and some of the recommendations that we make are germane to what you have been discussing today and what you will continue to discuss tomorrow: there is a very strong need for research in a large number of transportation areas and transportation safety related areas, but from our point of view, and I guess I should really say my personal point of view, the structuring of that type of research has got to have a product. It has got to be more present oriented than future oriented. It has got to really focus in on what is doable with what is available and what technological tools exist to produce a particular product or system that is going to be safer or easier to operate or reduces possibilities for malfunctioning. That is a difficult thing for anybody that is involved in pure research. I must say that during the two years I spent as Inspector-General of Foreign Assistance at the State Department, I got a number of looks at "monuments to nothing" that came out of government-funded pure research. The problem being that someone dealing in truly pure research isn't interested in what is doable. He is interested in what isn't doable and the second you come up to the point where, "Hey, we can make this happen, or we can do this," there is a loss of interest and let us go on to the next esoteric subject that we can find and push further out into the horizon.

I think that from our point of view, from an operational sense, those pitfalls have to be avoided. Our primary interest in the operation of any system, is "what is doable?" and "what we can do to improve in a modular way rather than waiting for a complete replacement?" Take aviation as an example, and the air traffic system. I have been a pilot for 20 years and I have seen significant changes in air traffic, procedures, equipment, and I think 15 years from now the air traffic system is going to be completely different from anything that I have probably flown in the past. The ability to apply technology and the new systems that are being developed are almost mind-boggling to someone that is in the system and using it all of the time, but the danger is that nothing gets applied at all. I started with Secor Browne when he was Assistant Secretary of Research and Technology at the Department of Transportation in 1969. There was a rather large, rather distinguished group of people working then on the air traffic control system, its profile, its design, and its future. The entire discussion revolved around 1990 to the year 2000 and I had just put in my 7,000th hour as a pilot, roughly, and I kept asking these guys, "What the hell are you doing for this afternoon? I don't give a damn about 1990. I want to know what you have learned in the research process, what you have learned in other disciplines," and I think one of the things that Phil and I were talking about a little earlier at dinner is that application of products and technologies and techniques that come out of a different discipline. For instance, the contributions that the aerospace development program have made all over this country that were in effect by products of the research that went into aerospace, are just phenomenal, but if the imagination hadn't been present to say, "Hey, this is a great thing. Sure, it was designed as part of the Mercury program or the Apollo program, but look at its other applications." What are the flexible roles that different techniques can play? Honeycomb bonding processing is a perfect example.

The general aviation manufacturing as well as the air carrier manufacturing industry would be nowhere near where it is today if it wasn't for the bonding processes that were developed out of the space research.

I think that all of us in the government, all of you in the academic community, have got to concentrate on those kinds of applications and don't get hung up in circles within circles. Talking to a number of you earlier this evening, I understand that in the course of the day there has been a lot of discussion of human factors as an area for research. Within aviation we have an airborne system and a ground-based system that embody incredible technological improvements in the last decade, but nobody has looked at the operator. Nobody has looked at whether or not an air traffic controller or a pilot who has essentially remained the same guy going from non-radar to broadband to bright displays, has now got "too much food on his plate?" Can he handle the technology that has been placed in front of him to operate the system? Why do you have mid-air collisions? Why do you have near-misses? You can put beacon collision avoidance systems in or airborne collision avoidance systems in or any damned system in that you want, and if the human doesn't respond to that system, when there is a lapse in the human factor that reacts to or energizes that system, the system in and of itself isn't going to do a damned thing for anybody. If you look at Carleton, Michigan, you have a situation where both aircraft were under under positive control with extremely good radar coverage, and yet they came that close to hitting each other. Why? Because there was an apparent failure in the human link on the ground.

In Spokane, Washington, it was apparent failure in the human link in the air. There was nothing wrong with the system in either case. There was no technological deficiency in either case. A collision avoidance system may or may not have given the pilots of any of the four airplanes involved an earlier read out. I know that you have a gear horn and when you are reducing power for descent you don't let the horn blow. You have got a shut-off switch and you pull it. You have got an altitude alert system. You know you are coming up on your altitude and you shut the damned thing off. I think that there are -- not only in aviation but in the railroad and the highway and maritime and all of the inter-modal areas -- terrific opportunities for human factors research. I don't think I would be prepared to say "Don't look at anything other than the human factors in transportation safety," but I would say that it is time that more effort went into the human side of the equation. I think the hardware is pretty damned good in most cases.

You have to know where you are going before you start researching, but I think that as you have dialogue, as you look at what the government is interested in learning about, what you are interested in proposing that the government learn about, what we in the safety sense in an oversight capacity are telling other government agencies that they ought to be interested in, the human factors should not be overlooked.

I sat down with Secretary Coleman and some of his troops about a month ago and Bill put a dollar bill on the table and he said, "That is all I have to spend on highway safety. What should I do with it?" Two hours later we weren't any further along in carving up the dollar bill than we were when we started except that the impaired driver, depending on whose statistics you believe, is involved in anywhere from 30 to 51 percent of all highway accidents.

Well now, that is pretty good reason to say that if we could just get the impaired driver under control we could reduce highway accidents by a substantial percent, because the pressure

on any government agency is to produce results that are identifiable. It doesn't do anybody any good to have a longrange program that they can't take the credit for. You have got to give those guys, us in the government something that we can get up here and say, "Here is the plum that I pulled out of the pie, what a marvelous fellow I am," and if you talk in long-term, long timeframe terms, the interest curve drops off very rapidly. It particularly drops off in Congress, even if you can sell the executive branch. I have been around long enough and on the Hill to know that it is 40 times harder to maintain the interest of a Congressman or a Senator in some long-term thing. If you can't define it in his interests or to short-term political benefit to him and to his district when he comes up for re-election, which he is going to do every other year or every six years, depending on where he sits, he is just not even going to waste any time on it. So the product has got to be there. It has got to be identified and it has got to be a marketable product and it has got to be a product that is compatible with what the agency or administration is trying to do. Parenthetically, this is very much influenced by this type of a gathering and this type of an interface. I would hope this is a continuing thing and not one that is left to once a year or so. When you don't all get together for a particular formal gathering or a structured gathering, there should be constant dialogue all of the time between the funders and the people providing the product.

I would just like to say in conclusion that in this kind of a two-way street I would like to leave with you the words of Oliver Wendell Holmes, the father, not the son, who said, "I pay the Captain of the Cunard Steamship to carry me quickly and safely to Liverpool, not to make a chart of the Atlantic Ocean for after voyagers." You have got to have a short-term mixed with the long-term. It has got to be a doable thing and within that context, if you are going to focus on any of the three as far as elements of transportation safety are concerned, the environment, the machine, or the operator, I would at this stage in the development of the technological art, say to have another long look at the operator before you get the system any more complex than it is. Thank you very much.

MR. BOLGER: Thank you very much, Mr. Chairman. I think there are two important points that we ought to take to heart here. One is that we concern ourselves with the human equation in our deliberations and, second, that we not forget the near-term as we focus on the longer, long-time look at our problems. Thank you very much, Chairman Todd, for coming to us and speaking to us tonight. That concludes our proceedings tonight. We will get together tomorrow morning at 9:00 o'clock.

PANEL II:
"PLANNING AND GOAL-SETTING FOR TRANSPORTATION SAFETY PROGRAMS, THE CONSEQUENCES OF PROCESS"

Moderator: Dr. C. F. Scheffey, Director of Research
Federal Highway Administration

OBJECTIVE: To relate the goal-setting process with the probability of attainment.

PANEL DISCUSSION AREAS:

IIa Standards of Safety.

Is it useful to differentiate goals in terms of reduction of accidents, reduction of injuries, reduction of fatalities, or reduction of probability of catastraphic accidents? Can meaningful goals be set in these areas?

How should standards reflect the differing risk rates of different groups: employees, users, public-at-large? Such groups have different safety expectations, receive different benefits and pay different costs, yet all interact in achieving consensus for goals.

IIb Willingness to Risk.

What is the impact of willingness to risk on goal setting? On risk variation from one mode to another? On risk variation from one group to another?

How is willingness to risk related to willingness to pay for changes in the risk level? How is this related to acceptance of safety standards? How can willingness to risk be measured? Be modified?

IIIc Development of Standards.

How does the development process relate to acceptance of the resulting standards?

What type of educational or public relations programs relating to risk perception and risk acceptance should precede or accompany the goal-setting process?

What role should be played by consumer groups, user groups, and other public groups in planning and goal-setting?

What role should be played by State and local groups? What is the national impact of local variation in risk rate?

MR. BURNS: Good morning, ladies and gentlemen. Mr. Scheffey will chair Panel II on the subject of "Planning and Goal-Setting on Transportation Safety Programs, the Consequences of Progress.

You may recall that yesterday afternoon we discussed in some detail the institutional problems as they relate to transportation safety, with specific areas of federal, state, local relations, federal-industrial relations, and federal-public relations.

Don Bennett mentioned as we left last evening, that it was a natural lead into the discussion that we are going to have this morning. We are fortunate to have with us today Mr. Charles F. Scheffey who is the Director of Research for the Federal Highway Administration. Chuck Scheffey, as we know in DOT, has a B.S. in civil engineering, 1943, from the Drexel Institute of Technology, an M.S. in civil engineering, 1951, University of California Berkeley, and an N.S.F., 1957, 1958 from the Technische Hofschule in Darmstadt, Germany. Chuck taught at the University of California in 1949. He then became the chief of Structure in Applied Mechanics Division, Federal Highway Administration. He is now Director of Research for the Federal Highway Administration. It is a great pleasure for me to introduce Mr. Charles "Chuck" Scheffey.

MR. SCHEFFEY: Thank you, Mr. Burns. Good morning and welcome to the panel at which we are going to address some of these questions of setting safety standards and the problems of risk associated with these. I think we ought to begin by saying honestly that we have lots of opinions on these subjects within the Department of Transportation, but we really don't have any really good solid answers, and while we are working on a lot of these problems actively, there is certainly a lot of room for discussion about whether we are addressing the problem from the right point of view and whether or not there are more quantitative and more precise methods by which some of these issues could be approached.

I would like to make just a few introductory remarks and begin with a few simple little numbers, taken out of one part of the DOT safety program with which I happen to be most familiar because of my immersion in the area of highway safety for a number of years. These are numbers that we discussed with some of the contractors and sometimes the inventors that come into our office in a steady parade with all sorts of concepts and ideas for saving lives on the highways. The numbers are $8.41 and $.26. The $8.41 represents the price of a device which, if required by the federal government on every motor vehicle in this country, will be equivalent to a tax of $1 billion on the owners of the motor vehicle fleet. The $.26 figure is the amount of investment per lane foot on just the interstate system and the primary system which constitutes a tax burden of $1 billion for the American public. I bring these numbers in simply to cite the fact that the issues that we are going to address here are big money issues.

We have lots of things that we know will work in highway safety in the sense that they will produce some benefit in savings of lives or reduction of injuries. The question really is one of allocation of scarce resources, and I think this applies across the board in all of the modal administrations. There is never enough money to do all of the things which we know how to do, or all of the things which may be desirable to do and in an area of scarce resources, the problem of how you best apply

the available resources becomes rather crucial.

The kinds of investment levels we are dealing with do extend into the billions of dollars whether we impose that burden through a direct tax measure or whether those burdens are imposed by requiring the consumer to buy a more expensive product in order to participate in the system. They are large sums of money and it is important that these decisions be made in the most cost effective manner. With that lead-in, I would like to simply outline first of all three areas that we are expected to address in this panel. The first one is the question of the standards of safety and whether or not these standards of safety can be related in some rational way to the willingness of the public to assume risk. This immediately raises a host of issues, one of which is the fact that risk taking willingness depends a great deal on the degree of control which the individual has over those risks. When you climb into your personal automobile, whether you consciously would articulate this or not, the evidence is that you are willing to assume a much higher level of risk than you are when you climb into a commercial aircraft and your safety is in the hands of other people, both on the ground and in the control cockpit of that aircraft.

The problem here is that we cannot very adequately quantify these risk-taking willingness, nor can we decide whether that risk taking difference between the cases where the individual controls, in some degree, his own safety, and where he is in the hands of others, is really a rational process.

The second area that we need to get into here is whether or not risk taking behavior, particularly where the individual is operating the vehicle or conveyance, can be motivated or can be modified in a way that will enhance the safety of the operation. There has been a great deal of effort on this in general aviation, highway transportation, and pleasure boating. In all cases the results have been extremely disappointing. The question here is whether or not there are new approaches to motivational activity that might enhance this aspect of safety in transportation.

The third area gets into the question of the participants in and the relative voice of those participants in the eventual setting of safety standards. In all modes of transportation we have governmental people who are responsible for operating the programs, commercial groups involved in operating this system, and consumer groups as either customers of that system, or as the operators of that system in the case of private vehicles.

The relative role of these different groups and of groups that are organized in one way or another to speak for each of these participants in the program is an issue of real concern to the Department and will be the subject of the third area of our discussion. Of particular interest is the question "can a change of process in the development of standards improve adherence to standards?"

At this point I would like to introduce Henry Wakeland, who is the Director of the Bureau of Surface Transportation Safety of the National Transportation Safety Board. Henry has asked for a few minutes to bring some of the insights of the Board to this panel before we open our discussions.

MR. WAKELAND: Thank you, Charlie. Yesterday you heard of the shortage of research directed toward the management and

organizational aspects of safety as compared to what was called the hardware or the alligator killing aspects, and what I have for you here is a paper* which describes a number of the values that society finds in safety. These are listed in such a way that you can use it as a checklist for studying what areas you might like to do research in.

The process of goal-setting and the process of standards-setting is vague at present, in terms of the values that are served. We have, at this point, a number of examples in which agencies have described why they employed a certain method to set a standard and we have, as we heard yesterday, the limit based on the benefit cost ratio to which Judith Connor addressed herself, but cost benefit is not by any means the only value that is served in safety and the only way in which society judges the need for a safety regulation.

In fact, there are real questions whether the recent DOT regulation dealing with a requirment for benefit cost studies will actually resolve the practical problems that have been occurring in motor vehicle safety standards recently. The example that Phil Polger gave us yesterday was that of the safety belt interlock system in which he pointed out that its reception by the public had been badly misguessed. The fact is that that safety belt interlock system was designed as a high benefit-to-cost ration device and it was really one of the most effective ways that restraints could have been brought into use. The reason it failed was that the rest of the social aspects of it had not been adequately predicted.

So the prediction of those other values is really quite important. Please refer to page three of this document. This is a listing of society's established values in safety measures. This list was obtained by reviewing a large number of documents in which decisions had been made by one agency or another as to whether safety measures would be adopted or not and also it comes from observation of the success or failure of different methods. There are eight different classes of these general concerns of safety.

The first one is the economic need for safety. Now that does not refer to the pure economic analyst's approach but to the public appreciation of the economic need for safety. It is the public appreciation which will govern, not an analysis which is done in vacuo.

The second one is public image and psychological motives for safety. There are many cases, particularly in commercial aviation, in which changes will be made for safety reasons to provide a public image effect, and if you want to look at the rail rapid transit field, you will see a great deal of that effect.

Item C is equality of treatment for groups at risk. A safety measure can be enormously valuable on a benefit-cost ratio and yet be discriminatory as to the treatment of risks for people. To give you an example, in the underride guard protection standard NHTSA abandoned their approach in that field on the ground that it was not cost beneficial. However, what they could not abandon, and the issue that is still present, is the fact that fatalities suffered by those riding in passenger cars as compared to trucks are approximately 2/3 of the total fatalities, so that is the type of issue that is involved there.

* May be obtained from Director, Bureau, Surface Transportation Safety, MTSB, Washington, D.C.

Prevention of unfairness to subject groups and avoiding risk, that has to do with questions such as the insufficiency of a warning, the provision of how we deal with risks where people do not know the risk and cannot control it.

The fifth class deals with protecting certain groups. Certain groups in society are better protected than others. Remember the old call of women and children first. In the sinking of the Titanic, many of the men who survived that sinking were criticized at the time.

Other values are the (6) position of safety action permitting technical improvements, (7) critical and non-critical timing of actions, and finally, (8) the right to privacy.

These eight classifications are broken down into about 19 different titles in the material. How can you make use of a list of this nature? Well, the first conclusion is simply this, that it is not possible, in my observation, to determine the probable acceptability of a safety regulation by studying the statements of the groups who are gathered to speak on a subject. Charlie spoke of the need to get participation. That is certainly part of it, but there must be systematic studies of the values that are present in a proposal and not only reliance of who squawks the most about what subject. Nobody was there to squawk about the safety belt interlock system and some of the major interest groups were proposing that it ought to be done, so it is necessary to study it.

That is where you come in. If you examine these values, you will find that they are not all matters for engineers. They are matters for social scientists, lawyers, and psychologists. A fairly broad spectrum of university expertise is involved in studying these values. Therefore, if you want to get into this field, to find some answers as to how to make the regulations more acceptable, look at the lists and try to see how your hardware task (which may lead to a future regulation of some sort) could be assisted by analysis from some other group that may be available to you in the university. The value of a university is that it is a "universe." It is not restricted to the engineering department or the sociology department. Look around and try to examine the values.

I hope you will find a couple of other ideas in this paper which may be useful to you.

MR. SCHEFFEY: Thank you, Henry.

Gentlemen, we will begin with the first topic here which is entitled "Standards of Safety" but really addresses primarily the question of how goals are to be set in these areas as related to the willingness of the public to accept risk and the cost of avoiding those risks.

MR. MONROE: Doing a little bedtime thinking last night over yesterday's proceedings, and the subject of today's panel leads me to introduce my remarks with a comment that I and the people I represent are a part of the problem you were trying to solve and having to cope with. We are consumers and I think possibly since you are looking for some advice, maybe I would give some advice, what I would call consumer's advice to bureaucrats and researchers. Remember, first, that we are the taxpayers. Whatever you do, we pay for. It had better be acceptable. Maintain a reasonable perspective. This is one of the difficult problems in Washington. History and philosophy

seem to suggest to us that man is not perfectable and so I suggest to you that successful management is a judicious practice of selective neglect. You haven't got time to do everything and you don't want to be overwhelmed with this decision-making process. Decision-making is always going to be made in the absence of complete knowledge. By flipping a coin we can get at least 50 percent right without any expertise or professional competence. We are looking for something better than that but we will be satisfied with something less than 100 percent.

Don't acquire the Messianic complex. Ms. Connor's remarks yesterday about the profession in which people are subjected to pressures and working 12 hours a day drew no tears from me. Leave the briefcase at the office. If you can't do your work in eight hours a day you probably aren't executive material anyway.

When you come to discussing R&D, even for aviation safety or any kind of safety, preserve a reasonable ratio of the R&D expenditures to the capital investment resources available to exploit those results. In talking with various people in research activities of one sort and another, I have found ranges of capital investment to capitalize on a dollar's worth of R&D to range anyplace from $20 to $100. So the scale of research has to be kept in some sort of balance.

With respect to the safety proposition, safety without a mission is pointless, but a mission without safety is self-defeating, so let us seek some reasonable safety levels, not perfect ones. Zero safety is an impossibility, and when administrators say "I will be satisfied with nothing less than perfect safety," they do nothing except turn off the great majority of people who recognize that that is an impossible goal, so let us set our safety goals at something which is reasonable.

We find that at least in aviation safety seems to be the result of experience and judgment. You apparently can't buy it with money because our safety record in aviation has remained almost constant over the last several years, despite massive growth in the amount of spending for FAA programs.

With regard to measuring the extent of risk taking, we can do a great deal more by way of both the conventional human factors work having to do with some of the perceptual things that enter and how they indeed are influenced by more personal and motivational factors. We need, however, to really bring a much broader spectrum in the behavioral and social sciences together with engineering and transportation. Indeed we need to mend our own house as well, because to wash a bit of dirty linen in public, motivational psychologists and clinical psychologists and social psychologists rarely talk to experimental psychologists and human factors people. We are farther apart in many ways than we are from engineering.

I think once we start to pull those teams together, and they are very different skills, once we ask you, as managers of research, to make sure that it isn't just the generalization psychologist, but that there are five or six modalities within psychology and you need representation from each of them or many of them to be able to do the job, maybe we will have the proper team or task force. So, so much for means of measuring risk. Frankly, we need money to study developmental processes in risk taking.

We know that there are different stages of life

development in which this takes many different forms. We found, for example, in some vastly different areas of research that the desire to take risk was very high in the abortion area among middle-aged women. This comes out as strange. All of a sudden this thing peaks after going steadily down over a period of years. The reasons for that we have begun to understand. We need to know more about that in the safety area.

We need to know more about social situations, what group phenomena affect risk taking. I mentioned earlier that a car full of teen-agers changes a very prudent driver into a great risk taker. We need to know a great deal about the family situation, what kinds of models were provided. We know darn well that kids are like their parents, no matter how much the parents admonish them to be different. Maybe the more they do that the more they are like their parents, or whoever the reference person is for them.

All of those things have scarcely been studied at all and yet they are very powerful factors in the measurement of risk taking and I would venture that after a couple of years

Research and rule-making results must either conform to general perception or verify something we suspect or if they are at a variance with those two, they must be so documented and so conclusive as to be beyond challenge if they are going to be accepted, and public acceptance is one of the things that you are looking for for your research programs and for your regulatory programs as well.

I was concerned yesterday and impressed by Dr. Grimaldi's remarks about communications. I say wisdom begins by calling things by their right names. Let us wipe out the gobbledygook in the technical language, if you want to communicate your results to us who have to use them. Public consumption is the end result you are looking for. In the course of my work I read a great many research reports. I find it very difficult to wade through a lot of this material, mainly because it is written for technicians or written for people within the discipline. There is simple, plain English and let us try and use it if we possibly can, because then we can take that material and use it in the development of our training courses. We can use it in the development of accident material which we publish in our magazine, and those we find are some of our best accepted and most sought after programs. There is a possibility to communicate here, but we do need to improve our communications enormously.

Remember also that what we are dealing with is a passing parade of participants. It is not a finite audience in a theatre. We have new people coming in. We have old people going out and a large stream in between transitioning from one to the other. The job is never finished. Repetition is one of the requirements in this whole exercise and hence your research results and your regulatory rule-making is going to wind up being used repeatedly and repeatedly and repeatedly if it is valid and if it is acceptable.

I would conclude with a remark that the difference between rape and seduction is salesmanship. We prefer the seduction of salesmanship, persuasion, and education, to the rape of coercion by law and regulation, and that is the nub of the human factor problem. Thank you.

MR. SCHEFFEY: Gentlemen, I think that is a good

beginning to our discussions. What kind of response do we have to these comments by Mr. Monroe here? I will be very specific. What about the proposal that the proper exposure index for all modes of transportation should be the number of operating hours for the particular equipment or vehicle involved?

MR. J. MARGOLIN: I wonder if I could take Dr. Monroe on in a rather basic issue which I think may be pretty central to our discussions of safety, maybe pretty central to many of our problems of safety as well. He spoke about the system and you, I think, agreed that precision is pretty important in this situation. He spoke about the system and then about pilot error or driver error, and I submit that probably our greatest problem in safety work is the failure to include the human being in the system. So as long as we go on making like engineers, as though we had a robotic system that did not include people, that did not examine the interaction between the human being and the mechanical parts or the electronic parts of the system, we haven't got a complete system, so here I am very concerned about that kind of a definition.

Now, going from that definition or redefinition, to what our standards are, I would like to extend them a little bit. We talk about reduction of accidents, reduction of injury, and reduction of fatality, or probability of catastrophic accidents, but the probability word leads me to something else. I think there is one more element that needs to be read into that and that is the reduction of fear and anxiety over a period of time that arises from the operation of a total system. The greater the length of period during which that fear and anxiety as a result of the travel experience exists, the more variable and the more error-prone one element in that total system is going to be, and that is the human element. An anxious person beyond the optimal point of being careful can be a pretty dangerous component in a system. Also, it has much to do with a frequently used term these days called quality of life, which we are supposed to be increasingly concerned with and I think that is correct, we should be. If many of our transportation systems produce a great deal of fear and anxiety, then perhaps we are not meeting our requirements. I would suspect that a lot of our automotive systems do that. I can only describe my first experience on the California freeway as scarcely being a joyful, pleasant, high quality of life type of experience, especially trying to get off and on.

The thing that I would like to do is stop there with just one statement and that is that I started as an engineer and I have gradually drifted through economics into psychology, so I grew up on the principles of parsimony, but I get anxious about them these days, because I find that there are more and more subtle variables that can have profound effects on safety and on the safe operation of a vehicle or a system. Therefore I am beginning to depart from this pressure for simple equations and starting to ask myself, as we talk in the second paragraph, about how should standards reflect differing risks for different groups, about some pretty subtle things which I will not expand upon at great length now, but let me ask just a few questions. Why do people take a risk? Well, they do it for personal reasons or for group reasons, so we need to take a look at the mission as Mr. Monroe pointed out. That mission itself can have some very profound effects on how the persons respond during the course of their experience with this travel operation. If they are operating under cooperative circumstances in which there is good morale, loyalty on the part of the employee, the employer, a sense of organization and common goals and so forth, and the

expectation of reciprocity, let us say, between the employer and the employee, you can expect not only greater risk, but, and this is a conflict in terms I guess, greater exposure to risk but also greater care.

We have done a lot of research in cooperation and competition and we do find that people, under conditions of cooperation, take somewhat more chances. They take somewhat more risks. They do them more carefully and if you look at it properly, there is not a conflict there, because they are more sanguine. They are more confident that their colleagues will support them, will feed back error constructively rather than destructively, so that before I get into an arbitrary discussion of differences in standards between employees and users and the public at large and employers, I would need to know a great deal more about the circumstances under which these standards are being established and that is where parsimony begins to break down.

MR. ROLAND (USC): I would like to focus back for a minute on Mr. Wakeland's opening remarks on this initial topic, the setting of standards. I was particularly attracted by the frequent use of "value" in your remarks, Henry, and I think this is a good point to begin with setting standards. I think, whether we recognize it or not, our standards must be composed of two parts. One part is the frequency of the event, and the other part is the value of the event, or severity, as people in safety tend to call it. I would suggest that for people that are setting the standards, it might be well to substitute "value" for "severity," but that is only one part, the other part being the frequency of the event.

If we are dealing with the public goals, and of course we must, because these goals must be accepted and these standards must be accepted, we have to deal with a level of visible standard which is perhaps a little less sophisticated than we as an institution would like to set to give us insight into the acceptability of the standard or goal. The public commonly views, I believe, accident results in terms of frequency, and the severity is sometimes overlooked. Of course, we group frequency by class, frequency of fatalities, frequency of injuries, merely frequency of accidents, but I think if we are going to come to grips in a meaningful way with our standards, we have to put the value in there in some way (and I think this is the big lack in our knowledge state right now), how do we set values. We have been setting frequencies. We have been setting rates for a number of years, but the value establishment is very difficult. Just quickly thumbing through Henry's paper, I see that he has called up a number of interesting aspects to the value question, and I think that one of the strong recommendations that should come out of this workshop would be some research on value establishment or severity levels. I think we can use those terms almost synonymously.

I think once the institutions have adopted value goals, that we can couple these with the frequency of the event and provide public visibility to a standard which focuses principally on the frequency of the event, but which is backed up by the value standard to give us a total measure of the effectiveness or performance level of this standard.

MR. BENNER (NTSB): I can't let this value question go unchallenged. I am Ludwig Benner, citizen, voter, public official, public employee, and a few other roles. We have quite a value expression system in our country and that is one of the

great things about it. We have individual votes on the expression of our values and I hear some suggestions made that the individual voting of our values, our personal value systems, needs to be substituted by public officials in this safety field.

I think if we are talking about research needs, it appears to me that one of the things that we need to understand better is how to translate government action into private decisions to move in the directions that collectively our government policies have tried to identify. For example, in the safety field, what is the purpose of the public safety programs? I think one way of smoking that out might be to examine that question by saying, "Let us assume we are 100 percent successful with our efforts. What would we have achieved?" I think we would find a number of sacred cows dropping out by the wayside. For example, there would not be a single life saved. Extended perhaps, but not saved. What would be the effects of perfect safety in transportation? Public confidence in the undertaking of the activity, perhaps, and an enlargement of the activity itself, but these are some of the question that perhaps would be worthwhile examining and would help the administrator in identifying a course of action that would find public acceptance, because what we are really saying in public acceptance, in my view, is that we will get the consent of those that we are trying to persuade to pursue this publicly-established policy of reducing accident losses, however they are measured.

We need to understand the reason people vote affirmatively with some of the public actions of some of our public administrators, and I think that we perhaps lack some understanding there.

MR. J. MARGOLIN: I think you have touched a very sensitive point and I am with you in wanting to go back to the voting, although votes were taken in a great many ways, so that the individual expression of values is maintained. Let me use a very touchy, I am hesitant to use this example, but it is one of the way in which efforts can be made by sociologists and anthropologists and perhaps psychologists to find out something about how you judge and study values.

For one thing, we start with values to whom? There are values to the individual, to the family, to the group, to the nation, and so forth. There is an interesting experiment, a natural experiment that has been taking place in this in the Middle East. This is where I am sort of hesitant to use the analogy, but it is the only one I have got. There can be, let us say, 100 deaths in the Israeli army and 1,000 or 10,000 in the Egyptian army, yet this is represented by a great deal of sorrow and weeping and tremendous value is placed on those 100 deaths by the Israeli community, culture, if you will, and not very much by the Egyptian community as a whole, although in the case of the wife, the mother, the family, I am sure the level of bereavement is just as great.

So we have a case, now, of the community or the nation responding differently, possibly because there are 3-1/2 million of one group, possibly because there are 60 million or 40 million of the other, possibly because communications are not as good. Possibly because the society is more accustomed to death through poverty. We don't really know what the cultural process is. We can learn that rather easily.

But this is one way of beginning to track causes and

ways in which values are derived, by beginning to take a look at the cultural values and some of the demographic economics, even some of the religious and family-size operations. However, as scientists, I think basically we have to draw up short. We can supply information. We can count the liklihood of "X" many votes being expressed in horror by one country and "Y" number of votes, or "X plus Y" numbers of votes in another country. Having made such a prediction, I think the question as to what the values of the country have to be at that point, I think we have to leave to our policy or political people. I think the scientist has to be terribly careful not to reach the point where he says an Israeli life is worth more than an Egyptian life or there are any way in which you really compare these values and make a decision for yourself. It takes a Secretary of State or somebody who gets paid for bearing that much risk, and now we are into another kind of risk, to make that decision. I think this is where the social scientist has to stop.

MR. KHASNABIS: My comment is directed towards Mr. Monroe's original remark. This has to do with establishing goals that are achievable on one side and that are desirable on the other side. I get the feeling that Mr. Monroe is talking about having a situation in which each accident could take place only because of human error, and that seems to me a very desirable goal. However, what concerns me in that is this something that we could really achieve and what are the trade-offs? I believe Mr. Monroe made the comment yesterday that if an automobile has go to go through a series of checkings and safety procedures, then the average cost of a Chevrolet could be as much as $66,000. When we are talking about a figure like this, there is the question: "Is it really possible to attain that kind of a goal that will permit the occurrence of an accident only because of human error?"

MR. SCHEFFEY: I think this whole question of the human as a part of the system is one that is very directly related to the risk-taking problem. Many years ago in the internal research programs of our own agency, we discarded the old cliche: "the cause of automobile accidents is the nut behind the wheel." We don't buy it. In fact, many times you have to ask the question, even in the cases where the analysis of the accident shows that the cause of the accident was, quote, "a human error," "did the design of the system place demands on the human that were unreasonable?" One must be very careful when you deal with privately operated conveyances as compared to those where you have a highly selected group operating a public conveyance. In the latter case you deal with the upper end of the capability distribution while in the case of the privately operated vehicle, we have to provide for impairment of normal capability out to a rather extreme limit in the tails of that distribution, the limit often set not by people involved in the safety programs, but by the courts and by the legislators who decide what is and what is not an infringement of private rights and whether or not you can grant a license.

So again the human is a part of the system and dealing realistically with his capabilities is a part of the design of the system.

MR. BERKHOUT (University of South Dakota): I would like to give some examples of that. People are also machines and we are not entirely sure how they work. I have been doing some work in perception of optical illusions as they relate to certain highway situations and it is clear that in many cases what is assigned originally as a human error or stupidity in an accident

can be analyzed in terms of visual inputs that created a false impression in the mind of a person which in some way contributed to the accident.

Whether he should have been trained in seeing these illusions and not have seen them is, I think, a moot point. The fact is that you can, at some point, predict that in any situation people make some errors. To give you a couple of examples, we have been studying emergency warning lights that get bolted to the roof of vehicles. Some of them with particular patterns of flashing, particular colors, have the nasty habit of looking as if they are receding from you when they are, in fact, standing still. If you have one of these things on the roof of your car and you are parked on the shoulder writing a ticket, somebody is likely to drive into your tailpipe. This is not a fairly frequent accident, but it does happen. The numbers I remember in California in the early seventies were somewhere between 15 and 20 occurrences of this kind a year, where somebody apparently assumed that the squad car parked on the shoulder of the road was moving and drove into it. People say, well, he must have been asleep. How could he have made such a dumb mistake? But the possibility that he actually saw the car as moving for reasons that deal with human perception, is one of the possibilities that has to be considered also.

There are other classes of accidents that I have had a chance to look into where truck drivers have demolished a camper parked on the side of the road. Again, the question was, did he fall asleep at the wheel? It is easy to check the trucker's logs. He has been driving all night and things like that, and yet when you look at the geometry of the situation, a low series of hills with the horizon constantly moving up and down, and with the relationship of the horizon to the parked car constantly changing, it is also clear that in this particular case this was an illusion of motion. It wasn't at all clear to the driver that the car that was stationary was in fact stationary. You could create a fun-house kind of illusion that the thing was in fact moving, and I can think of some other examples where interchange geometry and stacks of freeways sometimes give you the impression that cars are moving towards you at great speeds when in fact they are moving at right angles to you at some smaller speeds. One example is of cars moving around cloverleaf interchanges at night, when you can't see the entire body of the car, but you are just judging the headlights. Relative to the movement of other headlights you can sometimes get a real shock, and suddenly feel that a car is driving right at you when in fact it isn't. It is going on a different trajectory. These are things that would be put down as human error or stupidity, but I think they are predictable. They are part of the behavior of people as machines. There is not such a clear line between where the human error takes place in the sense that those are just people and we have to realize that we are taking the bottom end of the distribution, or when you think that these are just additional topics for research that can become part of the analysis of the system.

I would like to make one more comment about risk taking. I enjoyed the remarks you made about group morale and the increased willingness to take what seemed like risks, but to do the job safer. I have never felt that people willingly take all that many risks at all. I think the risk-taking decision model of driver behavior is probably not a very rewarding one to use. I think that the level of risk that people are aware of taking is simply the level of anxiety that they feel and that they are not really making decisions to take risks, per se. I don't think you would ever find somebody, drunk or sober, passing

a car if he thought that he had one chance in 10 of not making it. I think that he will only pass another car on a highway if he thinks he has 100 percent chance of making it, but he may be wrong! I think the analysis of a decision-making model that includes programming in some willingness on the part of the driver to accept a finite risk of getting killed in the next 30 seconds is probably a mistaken one. You may find an occasional case like this. I think this is equivalent to vehicular suicide if you find it. I think it is very uncommon and I think in most cases driver behavior is predicated on the perception of a virtual certainty of succeeding in maneuvers that they are making. I have gotten rather annoyed sometimes at seeing the risk-taking models that assume people are willing to take some perceivably finite risk of getting killed in the immediate future. I don't think people feel that way but I think that certain types of hazardous environments raise their anxiety level without really any calculations or even awareness of the actual risks involved on the part of the people driving.

MR. J. MARGOLIN: Would you accept one qualification on that?

MR. BERKHOUT: Sure.

MR. J. MARGOLIN: Well maybe two. The first would be that sometimes that perception of danger does effect the psycho-motor behavior sufficiently to make a difference. The second is the one that I am really troubled with and maybe we have to factor into our situation even more and that is the group process. Let me play games with the words, "risk-reward". Unfortunately, in our society today, especially with part of the teen-age population, or the early twenties population, there is some reward for the appearance of risk taking. There is status involved in that. It may not be a large part of our population. I suspect it accounts for a sizable number of our accidents. A young man alone in his car will not take the risk. If there are four girls in the back and he wants to look like a hero who can cut in around those trucks, he may take a risk to look good. So the reward for risk as a part of group process may be one of the things that we all know about and needs to be factored into that process.

MR. BURNS: I was impressed with the comments made from our colleague from South Dakota and I think we can all agree that from a systems safety point of view that the human factor is very important. I think we can agree too that there is a lot that we don't know about the human factor. Now, having stated the perception or lack of perception on the part of persons who traverse the highway, the question came to me, knowing this, what do we do? How do we solve that problem? Do we widen the shoulder or what answers are available from your experience that you can suggest to us there?

MR. BERKHOUT: Well, I don't really know because I haven't thought about the problem in the terms that Mr. Wakeland suggested for capital investment per dollar of research done, and I have a feeling that if you come up with a suggestion that the entire perceived geometry of the nation's highway system be changed, it is not going to be terribly well received and shouldn't be. Possibly just some way of making people aware that this can happen to them, I have a very low opinion of driver education courses, but this is certainly one of the things that could be programmed into the driver education course. It might be a half-hour film on the kind of illusions you are likely to find, starting off with five minutes on what an illusion is and

showing people how lines of different lengths can seem to be the same and then showing them what kind of illusions they are likely to find on the highways. I haven't the slightest notion that this would do any good, but at least it is a start and that wouldn't be too expensive.

Another thing you can do is just start surveying your high accident intersections, if you do have a freeway interchange or you do have an intersection in an urban situation where you are getting a reasonably high level of accidents in the course of a year. Maybe you ought to analyze it from an optical point of view, from perceptions of people who are passing through.

MR. HUMPHREYS (University of Tennessee): I would like to amplify the statement that was just made. I am sure, as was indicated, we are not going to get a total redesign of geometrics of the entire highway system, but I think it is important that human factors people get the message across to engineers, traffic people involved in traffic safety, and maybe police officials that at some high accident locations human factors may indeed by the problem. I don't think we are getting that message across now for several reasons. If you talk to people about high accident locations they tell you it is the damned driver again, not the fact that there might be a breakdown in the system at a particular location. The system at a particular location can be corrected, whereas we might not be able to correct the system on a national basis. I am convinced that we still haven't gotten the message across to a lot of people that human factors must be taken into account, the driver must be taken into account in many of these situations and accident investigations, or on the scene investigations simply are not taking that into consideration in many cases.

MR. SCHEFFEY: I would like to assure you that my own agency has gotten the message and in our programs, approximately 30 percent of the money that we spend on safety research is on human factors aspects of the problem. We certainly would agree that it is a very important aspect.

MR. ROLAND: Perhaps we could put this another way. I think that we will all agree that all accidents are caused by the human. Whether it is in the concept, design, development, or operation of the system, all accidents are caused by the human. But what we are trying to do, I believe, on our national balanced approach, is to work with the hardware to somewhat mitigate the tendency for human error in one of these phases of system development or operation. We must cope with this error in concept design development and operation in some way.

As far as risk taking, though, I feel somewhat differently than the gentleman from South Dakota in that in myself and all of my friends, I sense that when they pull out on the highway to pass another car, they perceive a degree of risk. They do not perceive zero risk, and they accept this risk in passing for the gain in moving their car more quickly to their destination. I think we all take risks not just in driving but in everything we do. We perceive, consciously, a degree of risk when we climb on a chairlift with no guard, yet we see no chairlifts in the world with guards on them. I think all of these things are part of our daily life and the willingness to take this perceived risk is a function of these many human societal values that we deal with and is in the make-up of each individual, who is quite different in his willingness to accept risk.

MR. SCHEFFEY: We seem to have on the floor here several levels of awareness of risk. The perceived deliberate risk that was mentioned here in the case of the young driver who does it to impress people, the perceived risk of a driver who accepts the fact that he doesn't have a 100 percent chance of getting around that vehicle he is trying to pass and then, I think, another risk that is very apparent is the fact that when you go out and purchase the automobile, you have expressed a willingness to assume a certain degree of risk in operating that on the highways, or when you climb on a commercial aircraft you are in the act of participating in the system and you are assuming a risk and whether you are conscious of it or not your participation in that system is, to a degree, a mark of your acceptance of some level of risk. Maybe we can solve this and get it cleared up by some additional speakers participating here.

MR. WAKELAND: I think we can take this directly from part of Mr. Monroe's question that wasn't answered. He asked us what the element of exposure should be in aviation and he pointed out that you had a rate of about four fatalities per 100,000 operating hours. In commercial aviation and general aviation it is about the same. However, you can analyze that on a different basis. Our background material shows for general aviation a fatality rate of 20 per 100 million passenger miles which compares with .13 for air carriers. Now, that is a ratio of what, 20 over .13? It is about not quite 100 or so -- a tremendously different ratio.

I have heard that explained on the theory that people riding on air carriers expect or desire to be taking virtually no risk, whereas those who are in general aviation, particularly private flying don't care whether they are taking a risk or not. What that tells us is that we cannot accept any one single ratio for the expression of hazard, that we must look at what values are served. You must know what you are going to use your ratio of loss to exposure for. If you are going to use it to decide whether you as an individual would like to travel from here to Chicago with a friend who has a private aircraft, or whether you will go by commercial aviation, you need to know that this enormously different risk is there, and you do not know that. You cannot know it if you accept the per 100,000 hour figure, because the difference in your personal risk is hidden. We have found this frequently. We have other places where this same factor is found. For example, in the fatality rate per billion ton-miles of freight transportation, the difference between carrying crude oil by pipeline and by tank truck on the highway is around 1,000 to one. That is to say, there are about 1,000 times as many fatalities on the highway for interstate motor carrier transportation as there are for pipelines. Naturally, the trucking industry does not accept the "per billion ton-mile rate" as being a valid measure, and they are working very hard to figure out reasons why it isn't logical to use that. I find that everybody in general aviation wants to use the per hundred thousand hour figure. It is the customer for air transport who ought to be told what the difference is on a per passenger mile basis, so you can't limit it just to one exposure figure. You have to figure out what it is for and that is where the research on social science has to come in.

What I have been talking about here is a way to look at the problem and what I am saying is that you folks who are in sociology and law and other social disciplines, ought to be looking at these problems much more intensively so that we have lots of papers on this subject, not just a few discusisons at a panel like this.

MR. MONROE: I need a chance to reply. I called for some honesty. The table on page 35 of the Secretary's statement of transportation policy is a classic example of one of the problems that Dr. Grimaldi remarked on in communications. Here is a technically correct table which is misleading until you read the footnote which gives the comparison as being something completely different from all of the other data in the table. Hence, innumerable people have jumped to the conclusion here. All I am pointing out with respect to fatality rates is in the "per hour of operation" of the kind of vehicle (in our particular case as between air carriers and general aviation), the fatality rate is almost identical.

I think there is another interesting anomaly in this. Contrary to the experience in surface transportation, the incidence of injuries in aviation is about half of the fatality rate rather than being several times it. This is an interesting aspect of this problem. I think that quite often we have failed to focus on the things which will enable us to look at what are the implications? For instance, if the fatality rates are roughly approximate, then does that mean that air carriers are being regulated more than they need to be? Are we engaging in excessive costs or is the operation of that complex aircraft that much more costly to obtain that equivalent accident rate, or fatality rate? There are several implications to this kind of a question that you don't arrive at when you look at these. I am talking here in a public forum where we are talking with government and industry, presumably addressing issues of public policy making and it seems to me that presumably the government is interested in extending a roughly even hand to all citizens.

Now, there may be a use for the statistic that you referred to for individual risk-taking evaluations. I have no qualms or reservations about providing that material or those statistics. The only thing I would say is that when it comes to public policy making, the establishment of where government, as a matter of public interest, should spend its money in pursuit of certain programs, then we had probably better go back to looking at as close to an accurate exposure measure as we can possibly get rather than proxies which only sort of confuse the issue.

MR. FOLEY (FHWA): We were just talking here about rates and rates are a very convenient mechanism that we use to sometimes pat ourselves on the back that we are making progress. The public generally looks at things in terms of actual number reductions and these are a lot harder to get, particularly on the highway side.

The question of voting was mentioned a couple of times this morning and the vote on the matter of safety often shows up in what Congress does, what Congress tells us to do and, to the extent that our system works, I think it is a pretty good one. For some indication of the general philosophy of the American people take a look at what Congress has told us. They have told us that they want no commercial, or practically no commercial aviation fatalities and they go to all kinds of expense to make NTSB work much harder on that part of the problem than on the highway part of the problem. They tell us in the Department that we are too restrictive when we tell people they should wear motorcycle helmets, or that they should have interlocks on their cars. It gets back, I think, to Chuck's opening statements about what the public is willing to take a chance on. I just would like to say let us don't hang all of our answers on rates and I

would like to make one personal observation about general aviation.

It seems to me that in general aviation there are categories, there are ranges. I used to fly with a company pilot that I had more confidence in than any airline pilot. He was so doggoned conservative that if you were flying over the golden triangle you would say, "Is that Pittsburgh?" He would say, "Just a minute," and he would get a three-point fix and say "Yes."

MR. LACEY: I just wanted to make another comment on Mr. Monroe's most favorable fatality rate. Obviously he is searching for the rate that is most favorable to general aviation and I don't blame him, but there are other considerations with limited energy resources and the like and we are talking about transportation actually moving materials and people. Perhaps we need to quantify how much you are moving. You have faulted this table, but really when you put everyone on the same denominator and numerator, your 20 just goes to 19. It is not that bad of a lot that they have in the table there, and I think that really we need to be concerned about how many passengers are safely moved and go ahead and argue your hours of operation, but we are really looking at which mode is the most favorable to moving people around.

MR. SCHEFFEY: You are suggesting a more appropriate exposure measure is fatalities per 100 million passenger miles rather than vehicle miles or hours of vehicle operation?

MR. LACEY: Right.

MR. GRELLA (Materials Transportation Bureau, DOT): I would like to make some general comments on this business of willingness to take risks and possibly lead that into what I think is probably a case study going on in the United States today that probably should bear watching by anybody in the safety management field because it serves as the extreme of this business of the public needing to understand the risk or at least the regulators needing to know of the reason the public votes the way they do, as Mr. Benner pointed out. We have all heard many times that we have to maintain a reasonable perspective in this business. My feeling is that the biggest problem a safety regulator faces is how to exercise his judgment as to what a degree of acceptable risk is.

The extreme I want to lead into involves the nuclear industry and nuclear transportation. I think we have an actual situation going on where the degree of willingness of the public to take risk, or at least their understanding of this problem, is totally out of perspective. Those of you who are from California are probably well aware of proposition 15 which is on the ballot in June which could be the death knell for the nuclear power industry.

Here is a situation where the public is exercising its right to vote on an issue, and depending on the kind of information that the public has in making their decision on that issue the issue will be decided. In the discussion paper that was handed out to us under standards of safety, it says, "Is it useful to differentiate goals in terms of reduction of accidents, reduction of injuries, reduction of fatalities?" In the nuclear industry there are none of these. There have been no accidents, no fatalities, no injuries.

The next term is "reduction of probability of catastrophic accidents". In this particular field the whole business is aimed at reducing the probability of castrophic accidents. Can meaningful goals be set in these areas? I am only throwing this out as a discussion item because it is an extreme case in which there is not a reasonable perspective, in my view, between the degree of willingness of the public to accept risk at the present time in that area as opposed to other more commonly risky business that is accepted to varying degrees, such as traffic safety.

In the area of transportation we have this same spread of unwillingness to take risk. After a simple highway accident where the truck carried radioactive cargo, within two days the Governor of the state had immediate meetings to ban transportation through the state, even though there wasn't any injury or death, or even any damage at all.

I detect similar tendencies in this direction in the occupational health field where there is a great deal of reaction because of press coverage, things like the kepone example, may lead to an excessive degree of regulation taking place in the level of effluents and level of toxic exposure in the occupational field. Some of that reaction we have seen in the nuclear field is spreading over.

MR. BENNER: I think the point, perhaps, that would be useful to examine is the manner in which we perceive risks relative to certain decisions as individuals. This might be done by examining some case studies, such as the one Al has suggested, to try to identify how the public expresses its perception of risk for the type of decision it is being asked to make. For example, if I am a passenger and I want to make a trip to Chicago, how do I get there? Do I go with my buddy who flies a private plane, or do I get on an airliner and what role does the perception of risk play in that decision? If we decide we want to go to war, what role does our perception of risk play in that decision? If we decide that we are public policy makers and we have to allocate resources, how do we express risk for that decision?

It has been my experience in examining this question, that risk is expressed in many different ways. For example, the public policy maker who has to devote funds, should he count casualties? Should he count the bed-days, I have picked up a new one here from Dr. Grimaldi, should he count bed-days for the injuries that have occurred? Should he express the risk in some way other than the fatalities per billion man-hours? Should it be fatalities per trip, for example, in aviation? The actual decision made is how to make a trip on a public carrier. If you want to get from here to there, what choice do you exercise? For that purpose, how do you express the risk element of that decision? For writing a regulation, there have been some studies that indicate various reasons for adopting a particular method of considering the risk. I am sure you have experienced a variety of ways of expressing risk in some of your decisions. I think we need to understand much more about the different ways risk is perceived or expressed for different types of decisions.

MR. BERKHOUT: I agree with that entirely. You can break down your accident or fatality budget for different aspects of social function. One of the things that has always bothered me is that the people who are most concerned about nuclear hazards don't perceive train accidents on coal trains as accidents relative to electrical generation. They don't perceive

coal-mining accidents, and if you compare the fatalities in nuclear power plants (of which there are none) with the 500 or 600 fatalities a year that have to be budgeted for electrical generation with steam coal, then you have a balance which you can discuss here, but the public just doesn't perceive it that way.

Would it be feasible to write up an accident budget where the energy budget for the number of fatalities attributable to energy and the number of fatalities attributable to food tranpsortation are segregated so that you might do some sort of systems analysis to see which industries were contributing most of the accidents in each mode of transportation? From this you can tell people, "Look, the energy generating accident budget for this country is 500 or 600 fatalities a year. The food transportation accident budget is so much." Is this possible? Can it be done and do you think it would effect public perception of the hazards involved in these industrial processes?

MR. BENNER: This trade-off, incidentally, was examined in the construction of the Washington subway system. It was readily acknowledged that the system cost in terms of human life would be "X" lives and "Y" injuries, "Y" lost man-hours. That was discussed during the formative stages of the Metro planning. It is along those lines, apparently, that Dr. Berkhout is suggesting a budget, I guess. Is that it?

MR. BERKHOUT: Yes.

MR. SCHEFFEY: My own experience in this general area would say that we might convince ourselves that this was a rational way of looking at the problem, but the public perception too often involves factors that involve how "spectacular" is the accident. I happen to be involved in the investigation of one of the bridge failures that occurred in this country and the loss of life in that one bridge collapse was some 36 people, far lower than the average accident that occurs when an airliner crashes, far lower than the daily toll of accidents that occur in a wide variety of automobile accidents, and yet, for that particular catastrophe, there was a tremendous effort expended to find the cause, to find out whether or not other examples of that were likely to occur, so that the spectacular factor, I think, weighs very heavily in the public mind in their perception of how important a given cause of accidents is. I think this is probably what has distorted the perception on the nuclear problem. The image of a nuclear plant blowing up prevents a rational approach along the lines where we can compare it with coal-mining accidents, boiler explosions, and all of the other things that are already associated with the power industry.

Henry, your particular group has a lot to do with deciding when an accident is spectacular enough to investigate, so --

MR. WAKELAND: Yes, the one that you are speaking of, Charlie, which was the Silver Bridge case. Charlie was the key person in that investigation. That wasn't decided by us. It was decided by the President. He asked for the investigation and I think you asked for an additional $500,000 in the budget to complete that investigation. There have been other cases, like the Wenatchee case, hazardous materials explosion, methylene nitrate. We think it was over $700,000 expended by a variety of people for different purposes in relation to the investigation, but the one point I wanted to make was that we are not talking about some theoretical thing that is of concern to university researchers. We are talking about problems and distortion which

are going to govern national transportation policy and which will establish our state in the world in the near future.

The distortion you mentioned, the failure to count in the coal handling losses to compare that with the expected nuclear losses that are attempted to be prevented, if it is permitted to prevail as the predominant point of view, could very well result in our minimization of the whole use of nuclear power. All that does is change the balance of the world economy against us because it will place us more in dependence on petroleum. It has many spin-off effects. So as scientists and technicians who understand these problems and who are talking about them, it is our task to make these differences clear to the public. We are the ones who know what is in these and that is why we are exploring them, so you know, the need to do research in this value field is very great indeed.

MR. BURNS: For many years I was involved in the transportation of hazardous materials and along the same line that Henry Wakeland has mentioned and Al Grella and Ludwig Benner. I think fear of the unknown causes a lot of problems in this area; fear of a 40-foot trailer with class A explosives, bombs bursting in air, 500-pound bombs, 1,000-pound bombs, and so on. Yet during the history of the transportation of explosives by truck, we have transported, I would say, hundreds of thousands of these "bombs bursting in air" type commodities and yet, there were more people killed in a bathtub during the course of one year, than had been killed by bombs exploding in trucks in the history of the transportation of explosives. These are the types of facts that we have to face; these are the type of things that we have to look at analytically.

MR. DICESARE: Just one comment on that statement. I do have to bathe, if you will, to be social. The risk that you are adding with these explosives, is an added risk to my life. It is not necessarily independent. I either bathe or have that other risk. I have to bathe. Therefore, I accept that risk. I would hope that bathtub designers might get to the point and make it a little safer to bathe, but I don't accept that analogy.

Furthermore, I don't know whether we should bring the nuclear issue up. I think, with all due respect to the government and the government officials present here, perhaps all of the risks have not been made public to the people with regard to this issue. I cite the model used, I guess in Tennessee, to predict the risk of failure of one of these plants. The model assumed independent probabilities of all of the events occurring and therefore the risk was highly minimal. On the other hand, in the design of the plant, all of the control cables were placed in a narrow confining corridor where, if a fire occurred, which did occur, it was highly likely that the whole control system would go and it almost did. So perhaps we are not the ones that really know the trade-offs. Perhaps the trade-offs are really not totally known, may never be known, and therefore the political process has to sort these things out. I think the Governor, for instance, of the state that you referred to, has the right to hold hearings. The state government was unaware that these materials were being transported through the state. It was perhaps willing to escort these things and so forth. I think it works both ways, and I think these things should be looked at this way. I think we are looking at the nuclear thing from perhaps a self-righteous point of view. I don't know.

MR. SCHEFFEY: Well, gentlemen, we have had an opening series of comments and open-air thinking here, and I think we

need to try to address maybe more directly the primary purpose of this conference which is to determine how some of the disciplinary groups that are represented in our universities can provide some assistance to the Department in approaches to these problems, how we can get a more rational way of going about looking at these questions of risk in safety policies, and I would like to ask now that we direct our attention to two questions, one being what methods and techniques are available for making quantitative measures of willingness to take risk and secondly, what procedures are available for the motivation and modification of risk-taking behavior on the part of the users of the transportation system.

MR. J. MARGOLIN: I would like to go back one step to providing the matrix in which we are likely to get solutions to both of your questions. Your questions are a kind of deja vu experience. About five years ago I worked with the National Academy of Engineering. We ran a conference at Airlie House to interest deans of schools of engineering in behavioral and social science activity to see if we could get more of a mix and bring the disciplines together.

We had a very enthusiastic and interesting session at Airlie House and the ducks out there and the grounds are great, but not very much happened. I am delighted to hear the Chairman raise the kinds of questions that he has about the social and behavioral sciences and their roles in this. I doubt, however, if we are going to get either quantitative measures or solutions unless we can get some better communication between engineering, transportation, and so forth, and the social and behavioral scientists and maybe the economists somewhere in between there, because the styles of thinking are, at this point, just a little divergent. They don't have to be, as I can show with a couple of analogies, but they are.

The thing that troubles me most is that we have been providing human causes for accidents and then looking for engineering solutions. The first impulse on the part of some of the folks here was to say how can we redesign the road or how can we redesign the vehicle, or how can we do something like that? It is probably true that it is going to be cheaper as well as more effective to do some redesigning of people, and I don't mean behavior modification in the sense that produces blaring headlines in the newspapers.

But we do need to look at some of the situations in which people do things and are governed by laws. Psychology is a science too. Let me use one illustration of that. We have a little phenomenon called the goal gradient, which is a well established principle in psychology. When I describe it to you, you will see its analogy to some physical principles. It started in penology. We found out, strangely enough, that people with a 14 or 15-year prison term didn't do anything about escaping for the first 14 years. When they got to within a month or two or a week or two of the time that their term was up, strangely enough they would make an effort to escape. We began to look into it and found out that the closer you are to your objective, the more valence, the more attractiveness that objective has to you.

The analogy to the life cycle of a trip is pretty evident. The closer you get, I would bet, as a hypothesis, that there are more accidents as you get closer to home, or to what your objective is, because of greater speed and greater risk taking, because of the attractiveness of that goal, than there are at the beginning of the trip.

Now, the similarity of that particular principle to the laws of gravitation should be pretty obvious. The closer you are to a mass, a large mass, the more attractive it is. This kind of bridging between the disciplines is badly needed and psychology, sociology, even anthropology, which is a pretty descriptive kind of thing, have begun to contain this kind of principle and I think we have got to start to learn together to apply these things if we are going to design the kind of techniques that we are talking about, if we are going to come up with the solutions.

Let me use one example with regard to the solutions even though this may be premature. We can redesign the vehicles all we want to but there is a whole question of preparing people for their role as drivers. Yet the first experience that any human being has, other than being taught how to drive at age 15 by his parents, or being told to watch when he is 12 or 14, when he asked his father, or her father, how you drive a car, is driver education in high school, where that is available and when it is available, and if the youngster chooses to have it.

I would submit that one of our interventions, one of our primary interventions, would be to start earlier with the whole business about transportation, about how people behave when traveling, about map reading (and map reading, incidentally, is probably a major source of accidents, when a guy is standing there balancing the thing, trying to watch the road signs, trying to read the map, or worse, arguing with his wife about the fact that she didn't read it right, which produces a certain amount of the attitude that produces accidents). If we can get in there earlier in the life cycle of the individual with an educational intervention that prepares him for the elements of risk taking, for all of the things that go with travel, we will have taken a major step toward doing something about the so-called "nut behind the wheel". This should occur at ages 10, 11 or 12.

This is the kind of solution that I think we might be looking for as well as engineering solutions.

MR. SCHEFFEY: I would like to make a comment of my own on that, and that is that as important as we consider driver education, that the places where controlled evaluations have been made, the effectiveness of those programs have been extremely disappointing, and we don't know why.

MR. HESS (University of Michigan): I am an engineer and that is part of my comment. Most of the arena that we are dealing with has been created by and is still run by engineers. I have had an experience over the last 20 years with the human performance lab at Michigan, it or its predecessor, which I have admired. I would recommend to this conference a Ph.D. thesis by Dr. Chinnis, done in that laboratory under Professor Cam Peterson, on the point of risk taking in, and motivational risk taking in the driving situation.

More specifically, I would recommend that a good approach toward the question that we are dealing with would be to assure that a reasonable portion of the budgets of the agencies, either in-house or out-house, are clearly devoted to the man-machine system in the hands of the professionals, the people in the area of human performance, whatever that may be called. It is called engineering psychology at Michigan. It may be called different names at different places.

I see this too often, that with engineers in charge,

and with their sort of a tendency toward bias for anything which is not one of the hard sciences, that the human factors aspect, man-machine aspect, is either under-utilized or directed by engineers who are not necessarily competent to direct it.

MR. FOLEY: Getting to that driver training, teaching a driver what he needs to know, this is an area where I think it was pointed out that we haven't had good measured, controlled, solutions. There are some political reasons for that. It is hard to sit down and say, "Okay, you three are going to get driver education and you three are not," because we want a controlled experiment. Parents are going to raise cain because they want you to have driver ed. That is part of the problem, but what I really started to say was that the question of what the driver needs to know seems to me not being too well addressed in the driver ed. process. Congress has told us to take a look at each of the highway safety standards and perhaps this is an area where your knowledge and your expertise can be brought together to help us do a better job, help the Department do a better job in writing the driver education standard or whatever it might be called in the future. I just offer that to you as a task.

MR. BERKHOUT: I would like to make one comment about some of the inadequacies that I see in driver education compared to the flight training for pilots. One of the things a pilot has to learn is how to control an airplane that is out of control, and that isn't touched in driver education at all. They never get them on a skid pan. They never give them a piece of equipment that has anything wrong with it. They never give them a vehicle that has gotten out of control and tell them to get it back into control. This is taboo. You never teach people how to handle an accident. You only try and teach them that they are somehow moral lepers if they get into one.

MR. HESS: I spent last Sunday afternoon at Willow Run airport in one of the GM special out-of-control cars. The point I want to make is that over the years that I have watched that kind of a program it has never operated above 30 miles an hour and on the other side of the coin, a car, once out of control, can typically not be brought back into control, not on the roadway.

MR. WAKELAND: Not with present designs anyway.

MR. HESS: That is right.

MR. SCHEFFEY: I think probably the one example that we have where not necessarily out of control vehicles have been used in training, but certainly stress situation rather than normal situations have been a feature of training, has been in the training given to many of our highway patrols, and I think this has paid off.

MR. HESS: But my point, though, is that we take a human being out and tell him that now you have learned to do this at 20, 25, and 30 miles an hour, you have graduated. We build confidence in his mind that he might dare try that at road speeds, but if he tries it at road speed he will probably be killed. I don't know whether or not that is a good move in driver education, to teach somebody to do something that he can only do slowly.

MR. SCHEFFEY: Well, I think we are getting into an argument about some detail here.

MR. HESS: It is very important.

MR. SCHEFFEY: But the question here is how does this relate to the whole problem of modifying risk-taking propensity?

MR. BENNER: I think this discussion illustrates probably more clearly than I could articulate, the difficulties that stem from what in my judgment is a very basic need for research in the accident field. I investigate accidents and so I have run into this. What is this phenomenon that we are investigating? What precisely happens during an accident? What is the process that occurs that culminates in harm, unintended harm, and I submit to you that we don't understand that and one of the reasons that we have discussions such as just transpired here is that we don't understand the phenomenon adequately. To put this into perspective, we are faced with the problem continuously of, all right, I am going to investigate this phenomenon. What are the bounds of the phenomenon? Where did it start? Where did it stop? What is the means by which I can identify the beginning of the phenomenon and the end of the phenomenon that I am investigating? What happens between the beginning and the end that I can understand or that I need to understand? How do I go about acquiring the understanding of the process that started with what we typically call a normal operation and culminated in harm or the operation shutdown? I think that this discussion that we had illustrates that very, very fundamental shortcoming in the research field.

MR. AARON (Southern Illinois University): I want to try to get at two or three things that have been mentioned here. I guess No. 1, there is a very concerted trend in terms of developing emergency evasive type of driver training programs, particularly in states that are a little bit more progressive in this regard. I can say for Illinois we have been developing some curriculum products that will be appended to the state's driver education curriculum and in due time I hope that the great majority of our driver education students will have received some type of basic instruction along this line, because we too have recognized this particular problem for quite a number of years.

Secondly, going back to this notion of what I would call pre-driver education experience, there are any number of K through 12 type of curriculum products now available within the states and also NHTSA has a couple of K through 12 curriculums. One specifically that comes to mind is in the alcohol and highway safety area where the effort is to start the youngsters very, very young and develop these concepts so that by the time they get to the driver education age, they will have a certain behavior pattern pretty well established.

Third, in terms of evaluation, possibly many of you are aware of the fact that there is a very extensive evaluation study. The contract has not been let as yet, but there is a three-year, a little over $3 million evaluation project in driver education that is going to be initiated sometime in the next six months and so perhaps we will have a little bit clearer idea as to what components of the driver education curriculum are, getting the job done.

MR. MCKENZIE (Office of University Research): Fifteen years ago the Ford Motor Company found that a car going into skid is analagous to an airplane going into stall. In other words, there is some very basic physics common to both dangers. I guess it is old hat to a group of safety experts, but nevertheless,

there is a body of information in industry and elsewhere which could be brought together in some sort of a comprehensive study of these matters. Possibly there is, in such a long history of such things, room for a number of master's theses on skid, weather, etc., which would not only educate young people but also provide important review articles.

MR. SCHEFFEY: I would like to see if we can't steer back into the question of in what ways, what are the available disciplines, what are the available kinds of knowledge that are in the universities now that can be brought into this question of the motivational aspects of risk taking.

MR. TISDALE (FAA, DOT): I have found all of this very informative. I came here to listen and it has been a good listening session from the standpoint of learning and getting the different thoughts that these gentlemen have. I think that probably the thing that we in the government need most is some solutions in this human factors area. Bob stated that he would like to see these systems such that all accidents were 100 percent human error. Well, I don't think we will ever obtain that because I think you have got to blame the human all back through the different systems sometimes, the way the design is made.

I know that whenever we have, in the research and development area, worked up systems for use by the pilot or for the traffic controller, this human factor has always been a big element we have had to look at. Frankly, our engineers are usually deciding what is the solution to these human factors, and the operational people are very critical of our engineers. I do believe that the reason for this whole gathering is to expose to the university representatives who are with us the needs of government to use their resources and their contact with the grass roots that we in government are so inclined to lose. If we can get these people to use their resources, their knowledge, and their contacts to come in and to solve some of these problems or give us some solutions which use these dollars that they, as taxpayers, are giving us to use up here, I think it would be to the benefit of all of us.

I am very anxious to hear something expressed along the lines of what can we do, maybe, to sell these people, the public out there, what safety is? How do we get these government programs to best be responsive to John Q. Publick's desire to be safe?

Now, speaking as an individual, I find that if I know the risk, I know there is going to be a risk in the atmosphere or the environment in which I place myself, I will accept that, but I am very irate if I walk into something which I think is safe and it turns out to be a bear trap. To me safety is a matter of knowledge, of exposing the person to what the situation is and letting him make an honest decision of whether or not he wants to go into it, whether he wants to get in a general aviation aircraft or whether he wants to get in a commercial aircraft. I think that the universities have a resource out there that could give us great benefit in this area to understand and use our research dollars better.

MR. MONROE: I would like to build on what Don said. He touched on something that I think is pretty close to the problem here. It seems to me that risk evaluation, the decision to take risk, is largely, with few exceptions, the responsibility and role of the individual, not of the state. What the state can

profitably do in this area is to make available accurate knowledge of the risks and the cost of that risk removal, so that the public can then assess whether or not there is a need for the modification to remove that risk, whether it is worthwhile to them. I think you get into great difficulty if you attempt to dictate that thing, as for instance, was done in the seatbelt type exercise, whereas if the request comes from the public, then I think you have a much greater chance of success and that means that you have got to provide them with the alternatives, the knowledge of the risk and the cost of its removal.

MR. SCHEFFEY: Your comment is, I think, appropriate, and maybe it is a realistic criticism of what was done on seatbelts, but I don't think it is very realistic in how the political process works. Congress does not direct the Department to develop its safety programs as the public demands but identifies and focuses on specific safety problems. The Congress says get with it and get the fatality rate down in all modes of transportation, so a certain amount of activity by the Department on behalf of the public has to be generated within the Department and with as much help as we can get from all directions. Now, I am just indicating here that we have a responsibility that has been laid on us by the Congress which the public elects, and we have got to be responsive to that. We are really anxious to get at what kind of help can we really get from the social sciences and behavioral sciences in these problems. We are not getting very specific assistance even where we have solicited it.

Pedestrian safety I would cite as one example where we think motivational research could pay large dividends. On solicitation for proposals on some of this work we have got some of the most unimaginative type of proposals you could consider. We did not get, we did not smoke out any real fresh approaches to this problem. We got the same old stuff that we already know about and I would make a remark here at the risk of some real antagonism, that a lot of you university people don't do your homework. You don't do what you require of your own graduate students to do before you let them start on a thesis, and that is to find out what has already been done in the field.

Now, maybe I can stir you up a little.

MS. FREE: Getting back to what Mr. Monroe was saying about people having to know what the risk actually is, I don't think people know what the risk is on our highways. For instance, when you are driving, you have a false sense of security. You don't know that when your car hits a fixed obstacle exactly what is going to happen. You feel that that car is going to protect you or that the guard rail will protect you. If you do have an accident, chances are you will survive, but there are 55,000 people a year that do not survive, and if the DOT requires automobile manufacturers to make people aware of the safety features of their car before they buy it so that they know which car is safer so that they could buy the safer car, that could give people a different perception of what their risk actually is or if FHWA made people aware of what risks were on the highway and what would happen if they hit certain features of that highway, the highway might not appear as forgiving as the people thought it was.

MR. WAKELAND: I think there is a problem in that NHTSA now has the authority to make consumer information statements of that nature if it wished to do so and if it developed an objective measure. Now, objective measures are available. Bob

Campbell has done some research at North Carolina. There have been some results in New York in which risks were analyzed by car make and model, but this was for vehicles which were already out of production. You cannot analyze the accident rate for a vehicle which has been produced until it has been in a number of accidents. Therefore, you are never going to have an evaluation based on accidents that is valid for predictive purposes or new models.

DOT knows, and has recognized in its studies of the fuel economy and safety relationship that large cars are safer than small cars when a collision occurs. As far as I know, there has been very little effort to explain to the public the numerical relationship in that which is present there, which is a ratio of about three to one, that is survival in smaller compact cars is about 1/3 as good as it is in the larger vehicles. This is based on two different studies.

Now, does the public know this instinctively? Well, it appears that the public does, to some extent, and some questionnaires have shown that they do understand that relationship. However, it is not really in their minds whether it is a question of repetition and whether it is in their minds that determines what decision they can make. However, the authority is there. It is not yet used.

MS. SIMPICH (UMTA): One of my areas is the elderly and handicapped. I come into this conversation obliquely, but we are talking about willingness to take risks and goal-setting. One of the goals in UMTA this past two years has been to establish a regulation that gives the elderly and handicapped some of their civil rights back, or that is one way that they phrase it. Our administrator has recently signed the regulation saying that they will have transportation facilities.

Now, when we were working on this regulation, somebody said, "Well what about the safety aspects?" and the answer was, "Do you want a regulation or do you want research?" There has not been, to my knowledge, very much study of the safety aspects for the elderly and handicapped. Should there be restraint systems on surface vehicles? On trains now they can ride and they don't have any tie-down systems. Our regulation will put them onto rapid rail cars and onto any level entry vehicle. It will put the elderly, not the wheelchair user, on the larger buses and on small buses.

There are some institutional problems here besides the federal government's problems. Operators, for example, aren't particularly happy about having to carry the elderly and handicapped, but we are moving from a private institution of our systems being private to their becoming public, as UMTA is beginning to pay 80 percent of all of the capital equipment. So we have the operators not wanting to carry them, the vocal elderly and handicapped wanting very much to ride, and the federal government having to do the Congress bidding of being certain that they are included.

I would like to know about the interior design of a bus and whether an older person or a person in a wheelchair, will be like a bowling pin rolling around if there is an accident. I would like to know about the fare box and if he is going to hit the fare box. I would like to know about his facing to the inside of the bus rather than forward or backward. I would like to know, if we find out that his facing backwards is the best

way, the safest way, how to convince people that riding backwards is worth doing.

I think we maybe have our head in the sand. Nobody is asking for safety research on the elderly and handicapped. We talked last night about these two-page proposals. I personally would be very happy to see lots of two-page proposals bombarding UMTA on the subject of safety for the elderly and the handicapped.

MR. ROLAND (USC): I will try to comment on this field that you are so interested in, Mr. Chairman, of what could we do in the university, because I am from a university. Why don't we try to break the risk down into its two component parts, frequency and severity? I think that we have a number of techniques, network analysis techniques, by which we can attack the frequency problem. Now, of course when we talk frequency, we are talking about historical frequency and predictive frequency, and we look at the past only to predict the future. I think we have network analysis methods that can predict frequency.

In the human factors aspect of this prediction, we have much more difficulty than we have in the hardware prediction and the Lord knows the hardware is difficult enough to treat, but I think we can approach this problem fairly well, given some time and money and incentive to attack frequency.

But the value or severity of the event which goes into making up the total risk which we then must educate the public to perceive correctly, is a much more difficult problem. I don't think we have very good methods to approach the severity evaluation problem of these accidents. I do think that if we are going to allocate our resources in research to these two areas, that perhaps we should balance it towards the severity or value of the event rather than to the frequency prediction part of it.

MR. SCHEFFEY: I think there has been a great deal of work done on the severity side of the accident picture. We have in the highway game the simplistic answers which usually aren't very helpful. For example, a study was made quite recently, and I might mention this was done by a university, in which they assessed the cost effectiveness of different types of physical safety measures in the highway system. The effectivenss of guard rails was included. Because the thing was not looked at in a stratified sense, the net cost effectiveness of the guard rails came out which indicated that as a policy we shouldn't spend <u>any</u> money on guard rails. It ranked way down the list in what was a cost effective measure for producing safety, but if that sample had been stratified by the traffic levels on the different roadways, it would come out with a different and less simplistic answer which says that it is not a question are they cost effective or not, are they cost effective, but where are they cost effective? They are cost effective on certain kinds of highway features. They are cost effective on certain levels of traffic, and they are not cost effective on others, and when you get into any of these questions about where you put your resources, the simplistic answer is not helpful. You have got to get down into enough detail to answer the real questions of where and when and how, and until we are willing to face that, these generalities are really not going to be very helpful to the public or to the Department.

MR. WAKELAND: When you say it was cost effective or not cost effective, you are using a measure of what?

MR. SCHEFFEY: I mean compared to other places you can put your safety dollars which you don't have enough of.

MR. WAKELAND: Lower priority, then?

MR. SCHEFFEY: Lower priority, that is right.

MR. LACEY: I feel that almost any safety measure, if you stratify it far enough, is going to be cost effective. You can always adopt that argument with a generalized safety device, but to stratify means you are asking us to answer a million questions when we are only given the resources to answer, say, 100 questions, so you have to accept a certain level of generality or no answers will be forthcoming.

MR. SCHEFFEY: Well, yes. My point is that if the assumption of generalities is not realistic, then the answers are worthless, and where stratification can be done as a matter of implementation policy, then stratification to that level is appropriate in asking the questions.

MR. LACEY: And as in the case of guard rails, is stratification used in the implementation to the degree that is necessary to get it cost beneficial?

MR. SCHEFFEY: Yes.

MR. LACEY: I think not, or else it would have shown up to be cost beneficial.

MR. SCHEFFEY: I am saying that there is a need for more detailed study to know how that stratification ought to take place and that an answer that tries to lump everything in one picture is not helpful at all. I don't want to reduce this to a guard rail argument, I just threw that in to show the fact that when you get to the part of this program where the action is, you have to deal in specifics, and you have to avoid simplistic arguments because they are simply not pertinent.

MR. J. MARGOLIN: I am afraid that I am getting a little confused because I hear us trying to measure two different things and maybe that is part of the problem. We are talking about measuring the extent of risk taking which I think is an essential thing, and the other essential thing is this question of the measurement of the severity of accidents, and they are two totally different kinds of fish.

With regard to measuring the extent of risk taking, we can do a great deal more by way of both the conventional human factors work having to do with some of the perceptual things that enter and how they indeed are influenced by more personal and motivational factors. We need, however, to really bring a much broader spectrum in the behavioral and social sciences together with engineering and transportation. Indeed we need to mend our own house as well, because to wash a bit of dirty linen in public, motivational psychologists and clinical psychologists and social psychologists rarely talk to experimental psychologists and human factors people. We are farther apart in many ways than we are from engineering.

I think once we start to pull those teams together, and they are very different skills, once we ask you, as managers of research, to make sure that it isn't just the generalization

psychologist, but that there are five or six modalities within psychology and you need representation from each of them or many of them to be able to do the job, maybe we will have the proper team or task force. So, so much for means of measuring risk. Frankly, we need money to study developmental processes in risk taking.

We know that there are different stages of life development in which this takes many different forms. We found, for example, in some vastly different areas of research that the desire to take risk was very high in the abortion area among middle-aged women. This comes out as strange. All of a sudden this thing peaks after going steadily down over a period of years. The reasons for that we have begun to understand. We need to know more about that in the safety area.

We need to know more about social situations, what group phenomena affect risk taking. I mentioned earlier that a car full of teen-agers changes a very prudent driver into a great risk taker. We need to know a great deal about the family situation, what kinds of models were provided. We know darn well that kids are like their parents, no matter how much the parents admonish them to be different. Maybe the more they do that the more they are like their parents, or whoever the reference person is for them.

All of those things have scarcely been studied at all and yet they are very powerful factors in the measurement of risk taking and I would venture that after a couple of years of research, we could probably give you profiles of what that risk taker is like which we cannot do today.

Let me shift to the other question of the severity of risk. Here we have a lot of areas that are part of the social milieu or social system forces that affect what I will now call not the severity of the accident but the perceived severity. We can probably describe degrees of fracture. We can probably describe degrees of disability the way they are catalogued for Workmen's Compensation or some kind of court legal system.

The thing that we can't measure until we get more studies going into it, is perceived severity. These are influenced by social system factors like insurance benefits. An accident, whiplash, suddenly materialized at some point in the development of automobile accidents once it was recognized by the courts. It is hard to prove that there wasn't a whiplash these days and if the greater the gain (the more insurance the other guy has and perhaps the more the no-fault system operates) the more liklihood there will be of a higher perceived disability. There is social gain. You can take a look at a person and say, my god, if he has a certain kind of family in which he is the odd man out, he is going to perceive his disability as being a great deal worse because that is going to get him some sympathy from the family.

There is anger at the perpetrator, the person who caused the accident, who hit you from behind. Incidentally, here we get a beautiful phenomenon. I am now treating one person who caused the accident in which she was injured and I have got a first class depression on my hands. She is furious at herself and that happens to be part of the etiology of depression. If you can't do anything about it, there is nobody to punish. She punishes herself.

There is the total effect on something like schooling.

We know very well that a sore throat becomes a lot worse if it is just before an examination and it will keep you out of school. All of these factors seem subjective. They are difficult to get a hold of, but if we are going to get valid measurements of severity, or of perceived severity, which is really what you are finally dealing with, they have to get accounted for. Otherwise we can proceed to make our objective measure and find out that they don't square with the real level of disability of the individual.

We simply need more time and more resources to begin to weigh and measure how those things count.

MR. WAKELAND: I want to put another dimension on this that hasn't been mentioned yet and which requires an additional university skill. We find accidents in all of the modes of transportation where there is an operator that we think are due to economic pressures on the operator to complete the trip or to get there at a faster rate. We are having great trouble identifying those and making them appear as causes of the accident. They occur in things like the unwillingness of a ship captain to reduce speed in the fog, operating practices in aviation, in railroads wherever there is a hired employee who is supposed to be acting in a certain way and who takes risks in order to obtain a direct economic gain.

We know that his willingness to take risks in these fields can be influenced by the form of economic regulation that the carrier may be under. It can be influenced by the way that his work contract is set up, who he is working for and how he is getting paid. I think, that if someone would look at this problem across the modes, we might be able to find a degree of order in it and be able to get at the correction of this kind of pressurized risk taking that really has very little to do with the things that Professor Margolin is speaking of.

There is one other aspect too and that is that we haven't differentiated between a risk which one accepts for oneself and a risk which one imposes upon others in order to achieve a gain. Much of the rationale for highway safety laws is based on the idea that you need to be controlled in your driving not just for your own protection but to prevent you from doing damage to someone else. It is not only the casualty to the teen-ager who doesn't realize what he is doing. He is hurting other people as well. We see that in the alcohol field especially where the improvements that you can make (the improvements that have come about and the improvements that were measured in some of the ASAP programs) show that there is virtually no gain, no improvement in accidents, which involve collisions with other vehicles. This meant that the program was only self-protective for the alcohol-involved person and not of great benefit to the rest of society. These are additional areas that someone needs to look at.

MR. LOFGREN: While you are waiting for answers on how the social sciences can help in this area, I want to mention a factor that I think is very important and I haven't heard it stated explicitly, and that is the very rarity of severe crashes. Fatals in highways accidents, for example, are now about one per 30 million miles of travel. I suggest that this greatly effects the credibility of the warnings, the admonitions we might give to the driving public about specific risks, because in their own experience a severe crash is a very rare event.

In response to this last remark by Henry, regarding protection of others, the safety belt use law that has been in effect since January 1 in the province of Ontario, makes the driver responsible for the wearing of the belts by anyone under 16 years of age in his car, in addition to being responsible for wearing the belt himself.

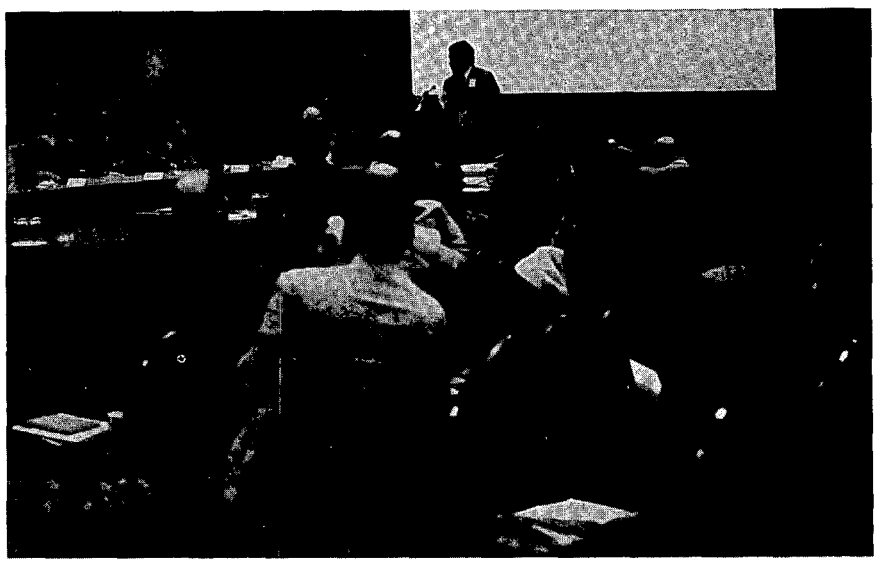
SPEAKER: I ask this question out of ignorance more than anything else. Have there been any studies showing the relationship of risk to insurance availability? There are different variations, of course.

MR. SCHEFFEY: I don't think I can answer that question. Can anyone in the room cite a specific study that has looked at this aspect of the problem?

MR. TAYLOR: Is it relevant?

MR. J. MARGOLIN: I only know one thing, it is the casual comment between them that gets made in the car, which is as you almost missed a beat-up old car, somebody will say to you, half jokingly, "For god's sake, don't hit him. He probably hasn't got insurance."

MR. SCHEFFEY: I want to thank the panel participants for their work with us. I think we opened a lot of questions and perhaps we generated some new thinking. We are hoping that we will get further comments from you by correspondence or otherwise. We are also hoping that some of the thinking that has been discussed here will show up in proposals that come in to both the university program and through the participation of universities in the contract programs of the different administrative R&D programs.



DR. MICHAEL J. RABINS, DIRECTOR, OFFICE OF UNIVERSITY RESEARCH
ADDRESSING THE CONFERENCE

AFTERNOON SESSION

MR. BOLGER: While we are finishing our dessert, and getting ready for a talk by Mr. Flohr, let me just introduce him to you. Bruce Flohr, has been the Deputy Administrator of the Federal Railway Administration since last September, and prior to that was with the Southern Pacific Transportation Company, San Antonio Division for many years and also with the Southern Pacific. Bruce, as Deputy Administrator, serves as the chairman of the FRA safety committee which reviews all railroad safety regulations and standards and recommends actions on proposed regulations, so he is somebody who has a rather strong vested interest in our safety discussions.

Bruce is a native of Idaho, received his B.S. from Stanford University, and an M.S. in industrial administration at Purdue in 1965.

MR. BRUCE FLOHR, DEPUTY ADMINISTRATOR, FEDERAL RAILROAD ADMINISTRATION

OPPORTUNITIES IN RAILROAD RESEARCH

Honorable Bruce M. Flohr, Deputy Administrator
Federal Railroad Administration

Phil, thank you very much. It certainly is a pleasure to be here today. When Phil first called me and said: "Would you like to speak?" I said, "Very definitely, yes," for a couple of reasons. We can carry the analogy of an alligator through a little bit and ask: "Who is really the alligator?" Because it is rather unique, I feel that within the railroad industry there are lots of alligators. There are alligators within our own DOT, there are alligators within the industry, and there are alligators outside the industry. What I would like to do today is highlight some of the things that have caused a uniqueness within the railroad industry and then summarize it in such a way that we are starting to drain the swamp. It is an awfully big swamp but I think that we can do it in a way that we can satisfy the alligator's problems as well as the rest of society's problems.

First of all, what are the alligators? You had available to you as part of your package something that was entitled "The Guidelines of Conference Workshop on Inter-Modal Safety Research Needs," and when I was trying to decide my subject of discussion today, I felt that this was a good document on which I might be able to base my discussions, so I went through it and the first thing I came up with was on page two. At the bottom of the page there are some numbers that are entitled, "Trend in Fatality Rates, 1949 to 1973" and, lo and behold, under the railroads, it is entitled, "Railroad Passengers." Concept problem: what is the alligator in this area in railroad safety? Last year one passenger was killed on the railroads. The year before, four passengers were killed on the railroads. Clearly, the alligator isn't here, so I would like to correct that thought first.

In the railroad industry, we look first of all at employee statistics. Fatalities for railroad employees in 1974, were 140, in 1975, 113. Definitely a trend that is going in the right direction. It is going downward. Then we talk about what other kind of fatalities, what are some of the other alligators out there in the railroad industries?

Grade crossings is another example. In 1974, there were 1,221 railroad grade crossing fatalities. In 1975 that number went down to 910, or a reduction of 311 fatalities. I would like to point out a little bit more about that. In reaching this reduction in fatalities, we can give credit to the highway departments for separation of roads and railroad crossings, but more, we can look at states like Georgia. They cut their accident rate in half. What they did was to talk about enforcing existing laws. In that state there is a state law that requires that all automobiles stop at all railroad crossings, regardless of whether the flasher warning systems are activated or not.

They got people sincerely interested, as a result of several real catastrophes. They put stop signs up at every railroad track and they also issued a ticket to everybody that drove past that stop sign without stopping. They cut their accident rate in half. So progress is definitely being made in these areas.

The next thing I did in reviewing this same report was

to turn to page three and down at the bottom in a big circle it shows "Transportation Industry" and they talk about cost of accidents in terms of fatalities, injuries, damages, repairs, increased insurance, and the decline and shift in use. I feel that this, perhaps, is one of the greatest areas of concern for the Federal Railroad Administration because what we feel is really the problem here is not so much the railroad employee and definitely not the railroad passenger-user. The alligator here is the catastrophic accident that the third-party, the non-involved individual, suffers from.

Now, when you are at home or looking out in your yard or when a plane flies over, do you ever think about the fact that that plane might crash in your yard and you might be injured or killed? No, you don't do that. When you are out on a highway or even walking down a street, do you ever think much about a car or a truck coming by, having an accident in which you are an accidental involvement? No, you don't think about that. But you talk to somebody that lives next to a railroad track and they are scared to death of the trains operating in our country. The reason they are terrified is because of a few catastrophic occurrences, and they feel they may be helpless victims of an accident that might occur in their community. You can bring up examples like Laurel, Mississippi, where there was a train carrying liquified petroleum gas. In this case, there was a mechanical failure on a car and it wiped out the town as a result.

There are other cases. There was a similar accident in Illinois. When we talk about problems within the railroad industry and about rail safety, we have both the area of human accident where the individual who is working on the railroad or being carried by the railroad can be injured, but we have a far greater responsibility when we look at the innocent third party who can very much suffer because of an accident. I think you have all either been through a town, or possibly grew up in a town, population less than 10,000 people, and in almost all cases there is a railroad track that goes right through the middle of the town. If you go down and watch that train come by you feel the ground shake. You see tank cars go by and a tank car means hazardous commodities as far as you are concerned. Well, there is more vegetable oil and salad oil shipped in tank cars than there is liquified petroleum gas, but the impression is that there is disaster 20 feet away from you -- and it really has people concerned.

So when we talk about how do we direct our safety activities, we have two very real areas that we must look at. We must look at the personal injury area involving the railroad employee and secondly, we have to look at the accident that will effect the bystander.

The third area that I thought was important in reading this same report was in Appendix I and listed on this page are transportation safety statutes administered by the Department of Transportation. There is a whole page of statutes listed here and yet the FRA didn't even make the list.*

This isn't intended to embarass any one particular department within the federal government, but it does go to show what has happened in the past in this area as far as railroad safety and railroad research is concerned. We have been sort of

* A typographic error that has been corrected. Appendix I now reflects the responsibilities of the Federal Railroad Administration. Our apologies to the FRA. [Ed.]

the tag-along behind and until about three years ago, it was a very regrettable situation. But why did we ever get in this position? The main reason is that the only time you probably ever think about railroads is as a passenger on a passenger train. Passengers today on trains just are not important. We in the administration have certain discomforts with Congress as far as money that is appropriated for Amtrak, but we are talking about less than a half of one percent of the total passenger miles involved in trains right now, and there is very little likelihood that it will significantly increase other than in the area of Washington to Boston. Even there we are talking about more of a super-subway system where you have high density populations scattered all along the corridor.

So we have had an image problem. Secondly, the railroad industry is really a wholesaler. The cornflakes that you eat, the table napkins that you use, probably came by rail, but I never think of it that way and probably you don't either. That is because the railroad products are all wholesale products as far as you as a consumer are concerned. Therefore, you don't think about railroads, so the railroads have had an image problem. That image problem finally reached the point of the bankruptcy of the Penn Central, and, later, the bankruptcy of the Rock Island and certainly the other northeast carriers.

It also pointed out that it was not just a northeast situation. It was a nationwide situation. Finally, the administration was able to get a bill through Congress that we hope will go a long way to correct the railroad problems. Things are now moving in the right direction and it is important that we recognize that they are moving that way because we still are talking about a mode of transportation that involves more than 40 percent of all of the merchandise, on a tonnage basis, hauled. We anticipate with this legislation, and with such things as John Snow talked about on the regulatory reform issues, that the movement will continue towards railroads. This is important, because it is going to have a lot to do with where dollars are spent, and dollars are going to be spent in the research area and that is the way that I am getting to the real subject today.

The new Rail Act, first of all, emphasized that finally Congress is aware of the importance of railroad freight in our nation's economy and they let it be known loud and clear in a manner that had never occurred in the past.

Along with this, there has been an attitude change within the railroad industry. When you have zero earnings or only small earnings, you can't justify to your Board of Directors or to the stockholders spending your money on research. Even worse, within the railroad industry, if you did have some pretty good ideas, not only is the front-end financing not available, but along with that, the return, the direct dollar return on your investment, really isn't available.

There have been some exceptions to the rule. If you are at all familiar with the industry, there is the case of the Vertapak car carrier. This is basically a flatcar that was modified to carry Chevy Vegas. The cars are driven onto the sides of the car when they are lying down open and then the sides of the cars are folded up into a vertical position and the automobile is carried nose downward across the country, each Vertapak carrying 18 automobiles. It was developed by private industry.

The main reason they did it that way was to overcome the vandalism problem on automobiles. The largest single

payment that railroads make as far as freight loss and damage is concerned is automobiles. Right now all automobiles are hauled by rail for distances over 300 miles. But between the kids with rocks in their pockets, and the nice supply that the railroad always keeps on their track, and now the development of pellet guns and b-b guns and even more sophisticated methods of throwing acid and such things as that, the automobile damage rate has become critical to the railroad industry. Research has been done to improve the situation and steps are being taken because of the incredible cost and the incredible return for relatively simple fixes.

They have another solution, again for automobiles. Large sized cars now are loaded in cocoons. There are three levels in this cocoon and an automobile is placed in each one of them through a special loading device. The whole cocoon is set on top of a flatcar. Each flatcar can carry four cocoons. Again, enclose the automobile so it will not be subject to vandalism on the outside.

But these are only a few examples and they don't really get at some of the problems like the Laurel, Mississippi situation, or this thing of 90 fatalities involving railroad employees, so what else have we done? The Rail Act of February 1976, besides showing that Congress was interested, gave to the industry a signal that they are going to be returned to a competitive basis with the other modes. Therefore, money can start being invested in all of the problems within the industry.

The industry has already tried to address a problem in an area called track-train dynamics. What really goes on back in a train on that rail-wheel interface? Where this became important is as their costs increased, train lengths increased. They went from steam to diesel engines. You could tack on six, seven, eight locomotives on the head end and still have one man controlling all of them. Horsepower on the head end of a train isn't 5,000 horsepower or 10,000 horsepower; a railroad can easily put 50,000 horsepower on the head end of one train -- and if you are not careful with that kind of power, the engineer opening his throttle up too fast can just pull all of the guts out of that first car behind the locomotive. The railroads have been forced to this because of costs. Along with that, they cut back on a lot of their track maintenance, so the margin of error or the margin of safety, I should say, that had been there in the past, was narrowing all of the time. We can see the results -- 40 percent of all railroad accidents now are basically caused by a track defect.

The industry has addressed this problem through track-train dynamics. We in FRA have also addressed it by a joint effort with the railroads and the suppliers at our test center in Pueblo, Colorado, that will be in operation on August 1 of this year. This is basically a 4.8 mile closed loop rail line where we will be operating one train for 20 hours a day on a seven day basis. We will represent in one day, a little over a million gross ton miles. A railroad considers 20 million gross ton miles as a large amount of business for a whole year. We will be able to represent a year's worth of business in three weeks. Now, what are we going to do with this?

First of all, we will test track components, features in track construction that the industry wants to see tested prior to the time that they make major capital commitments in the track rehabilitation area. There are five different kinds of concrete ties including concrete ties from South Africa. We have

different kinds of rail fasteners involved. We have different kinds of ballast under the track. We have different spacing of the ties, different treatments to the rail.

But, along with that, we are now getting as much, or more, interest in the cars. We can test components in the cars to improve the durability of the components, or test for component failure. We are now starting to get inquiries from many component manufacturers saying "Can't we test our gadget on your train, on one of the cars in your train?" Well, our answer is: "yes," because that is the purpose of this facility, to provide something for private industry in order to improve the whole railroad system. Certainly one approach is reduced expenditures, both continual maintenance expenditures and accident expenditures.

Private manufacturers have been very interested in the test center (particularly Pullman-Standard and American Car and Foundry). Many manufacturers are contributing equipment or components of equipment in order to have them tested. The railroads themselves have donated all of the material. Federal dollars are going to the assembly of the track and they will operate the train, but even the locomotives were donated. The Southern Railroad donated three locomotives to be used for the first year on this project.

A test facility is available now. If you are interested in getting involved with railroad research, the door is wide open. It is open from the railroad industry because they now have some money and they certainly have the interest. It is open from the manufacturing industry because they concede that there is going to be an expanding market for railroad products and now they have that green light to start improving their products in a way they never have done in the past.

There are also several high speed loops at the test center to be used by UMTA for the testing of their vehicles. It is a golden opportunity to try out new ideas in the hardware component area. I encourage you to start thinking this way and approaching the industry and approaching the manufacturers, because there is a test facility available now that you can see in operation and you can monitor the product that is being tested. In the past if you tried to test something out on a railroad, first of all, that car was usually going several hundred miles and you kept having to run back and forth or catch it in between. If it was a track component, there may have been only 10 trains a day over that section of track and that might have required two or three years before you could get any meaningful results. Now all of that is changed and I think it is important that you are aware of it and how you can use the test center.

The other area of research that is a result of current actions is in the area of state transportation planning. This isn't strictly safety research on the surface, but it does get into that. The states now have an opportunity to continue operation on light density branch lines if the ICC gives the railroad the authority to abandon that branch line.

One of the basic problems is the high maintenance costs of these light density branch lines. States are now having to develop state rail plans so that they can qualify for the money. They also have the problem of how do they upgrade the track, safety again is an issue. New concepts are needed to assist the states in getting maximum rail service where the economics just

isn't there for private industry to operate it, but there is a feeling by communities that they should have the rail service. This is another golden opportunity, I feel, for research.

The last thing that I would like to bring up is a new attitude that is important in the whole R & D effort. Two months ago Dr. Harris of the Association of American Railroads was named the railroad man of the year. The importance of this is that a research oriented individual received recognition for his efforts in the railroad industry. In the past the railroad industry just was not interested in research. The fact that Dr. Harris got this award clearly demonstrates that the industry is ready now to participate in a very active manner in research activities. It is getting started now, but the key aspects of it are that we recognize the results of current projects and that we start taking advantage of changing attitudes so that more money will flow into the research area.

In conclusion, I would like to get back to our alligator analogy and say, "Remember, it is not the passenger that we are really concerned about. It is the railroad employee and it is that third party." We are not talking just about safety or personal injury prevention. We are talkig about catastrophic accidents that have occurred and we are hoping can be prevented. We are talking about changing attitudes, and they have changed. It is our responsibility to continue this new attitude and progress towards improvement in the railroad industry. The safety statistics for the railroads, a lot of people think, are bad. They think they are horrible, and if you look at the comparison with other industries, you might say that is right. The steel industry right now has an injury rate of around four per 1,000,000 man-hours, the railroad is at 18 per 1,000,000 man-hours. But there is somebody that is 36 per 1,000,000 man-hours, double the railroad's, and it is <u>not</u> the coal mining industry and it is <u>not</u> the lumbering industry; it is the airline industry! It is the ground employee in the airline industry that now has the highest injury rate of any craft.

I thank you for your attention and please carry the research message through because it is there in the railroad industry. Thank you.

MR. BOLGER: Thank you very much, Bruce, for the thoughts with respect to opportunities for research in the railroad industry and let me assure you, Bruce, we do love the railroad and we will get you on the list next time.

PANEL III:
"DEPARTMENTAL MANAGEMENT, INFORMATION AND EVALUATION PROGRAMS: DECISION MAKING IN A WORLD OF CHANGE"

Moderator: Dr. James Costantino, Director, Transportation Systems Center

OBJECTIVE: To describe research needs for management of safety programs. This includes data collection requirements, information systems, evaluation systems and management systems which provide the capability to evaluate the consequences of safety program changes on the mode involved, on other transportation modes, and on other national priorities.

PANEL DISCUSSION AREAS:

IIIa Information Systems

What are the requirements for data collection, data definition, storage, retrieval, dissemination and use?

How should departmental systems interact with other systems for technology transfer?

IIIb Analytic Tools and Techniques

What analytic tools and techniques are required for data analysis?

By what models should the social and economic consequences of safety programs be distributed by mode? by risk level? by class of user?

IIIc Evaluation System

Can evaluative criteria be established which measures all transportation modes on the same safety scale?

What evaluative criteria can be employed to measure program accomplishments? How should such data be collected and evaluated?

IIId Management Systems

What are requirements for integrating safety considerations into departmental management systems?

What is the modal transferability of safety strategies and techniques (incentives, licensing, fines, enforcement, etc.)?

MR. COSTANTINO: The idea of this session, as I understand it, is to be a wrap-up, sort of, of all of the panels that you have had to date and hopefully some of the information that you have gleaned from those panels can be put into the record here so that our university research and safety people can develop whatever recommendations they can. I am very pleased that one of the goals here is to improve safety guidelines for soliciation in university research programs. I sit as a University Research Board member and I am certain that all of you will agree that one of the things that we really need are some guidelines that will help the proposals that universities put together that come into the Department for review, rating, ranking, whatever, to be clearer and more precise. This makes the job of ranking them easier as well as giving you a better opportunity to win an award to do some research in this very important area.

I would like to comment briefly on a piece of paper that was handed out to you that was put together by one of my colleagues at the Transportation Systems Center, Gene Darling, which is called "Information Systems, Analytic Tools and Techniques, Evaluative Systems, and Management Systems,"* and this will probably be helpful to you in jogging your memory and in making some of the comments.

Let me now read to you the objective of the panel and then we can just start in with our comments, with our discussion. The objective of this panel is to describe research needs for management of safety programs. This includes data collection requirements, information systems, evaluation systems and management systems, which provide the capability to evaluate the consequences of safety program changes on the mode involved, on other transportation modes, and on other national priorities. It is a rather broad area.

Dr. Bartfeld, you are going to have to leave shortly. Would you like to make an opening comment?

DR. BARTFELD: I was not prepared to make a formal statement. However, let me point out here that I guess one of the things that came across in this meeting is our current narrow or relatively narrow information base. A number of speakers commented on the need for opening up areas into human behavior, effects of humans on the system, and so on. I guess the biggest problem to deal here with a topic that includes information and evaluation, decision-making in the world of change, is where is this information included? Where is the data base for this kind of information? I would probably guess one of the major problems that we have is how can we, in a reasonably cost effective base, expand the information to almost unlimited? I think probably the one area that we ought to try to look a little bit into is where do we draw the lines of what is necessary for the decision maker here, because from the speakers yesterday you heard all kinds of information, really that are not safety related or research related, but people related that have an impact. Where do we get this information from, or how do we put it into our system? Where do we draw the lines? What are the parameters and the limitations? That is one area.

The other area is very closely connected to that, the question of incentives and disincentives, that we ought to put

*Available from Office of the Director, Transportation Systems Center, Kendall Square, Cambridge, Mass. 02142.

into this system in order to come up with reasonable or reasonably good management decisions. How do we put this into the system? Probably one other area which, although this list is an extremely exhaustive list, is a list that probably in government agencies uses a dirty word, and that is "control", or "enforcement". We very often spend lots of money on research. I don't think we have a very good system that will permit us to find out what did we get for this money. I probably have given you a pretty broad description of where I think the problem areas are.

MR. COSTANTINO: Could you touch on, Charlie, very briefly, one of the questions that I see under information systems here is how should Departmental systems interact with other systems for technology transfer under the information systems area?

MR. BARTFELD: Well, there are a number of areas here where probably first things first, DOT does have the basis for a very good information system. The question is, is it sufficiently large? Is it sufficiently institutionalized so that you really can have the minimum critical mass for making it an effective system?

One of the problems that exists in any information system is really where is the critical mass to make it effective so you will attract more and more users of the system who are willing to pay some of the upkeep? I think we have relatively little knowledge how large a system has to be and how effective it has to be in order to provide information, not only to the federal government or to other state governments, but to more and more private users.

MR. HOSHOVSKY: I am not quite sure that there is such a thing as a system of information either within the Department or even outside of this Department. We do have many data bases and many data collections and we, in fact, have a variety of proposals to mechanize the data bases and make access to it and so on. What we don't have, however, is a good understanding of what really exists in this whole area. I have sat on a number of discussions and the discussions are directed at the question that "If only we had good data, we would make good decisions" about either a rule that is about to be made or about transportation systems that we should make investment in and so on.

What does happen usually after this, after we specify what ought to be known, the assumption is that we need to immediately create that information and assemble and build one more system somewhere on the side, where in fact when you look at a good number of studies that have been made, there are very large data bases, including a study made by TSC, for instance. There is an immense number of data bases in this country that have been collected, both about people, about operations of railroads, or cars or roads, or whatever. The problem is that the data usually is inaccessible. First, it is unknown to a majority of users and second, even if it is known, an average user, a professor at the university, a researcher or decision maker hasn't got the slightest idea how to get to it and even if he can get to it, he probably wouldn't know what to do with it when it starts coming out.

MR. COSTANTINO: Alex, what kind of a research program or area of research could you articulate that would come to grips with that problem? Is there something that Mike Rabins and University Research could put into a university research project?

MR. HOSHOVSKY: Yes, I think I could, and this is the area of defining, quote, "requirements". It is a word that is misused very often. Everyone defines requirements for whatever you do, but I think in the area of information it is so diffused and no one has really put enough money for going to the universities, going to the state and local officials, going to the decision makers and making a good inventory of what is really needed, in what form, in what kind of timetable, and what kind of degree of quality and so on, and put it together and saying, "All right, this is the nature of the problem". I don't see it anywhere. I see pieces everywhere, but there is no integrated picture of a problem, especially with respect to the area of safety, other than when Phil Bolger made a study on TRANSIS. But even that, that was looking only at the Departmental needs.

MR. BOLGER: Yes, that was just looking at what was available, really, in the Department, but there isn't any understanding really of the needs, I think is the word that you are saying. You are using the word "requirements", but I think of it as needs, and I think that would be something that we could really look for some help in, because we are always saying that we don't have enough data, but what kind of data?

MR. HOSHOVSKY: Precisely. Or to put it another way, if an individual is interested, let us say, in the Department or elsewhere, in investing resources into improving data base access, let us say you have an individual like this, he is helpless because he really doesn't know the characteristics of the needs that he is about to solve and he is unable to get the necessary resources, or to know what to do.

MR. COSTANTINO: You are suggesting that one of the research areas is to define and this probably has come up in an earlier panel, but to define just what it is that you are after.

MR. HOSHOVSKY: With some degree of precision.

SPEAKER: This last comment covered partially what I was going to say, but I was going to make a rather negative remark, some negative comments. I have been, as many of us, in the data business for many, many years. One difficulty has been we often collect information we don't need. We are not sure of the needs that are involved. We are not sure of the costs that are necessary. We have all kinds of data collections, the government has, in many areas. Much of it simply isn't used or it hasn't met the purposes. So, make damned sure you know what you want, what the costs are going to be, include the question of accessibility, and the type of data that should be collected, and determine whether it should be a sample, 100 percent, or whatever it need be.

This is a very touchy area, I know.

MR. BOLGER: That is what I meant by needs, though. I think we are saying the same thing.

MR. TANG (University of Illinois): We have been doing a study on the safety analysis of multi-modal projects, including rail, highway, and air safety and we are using a fault tree analysis approach. We find out that using that kind of approach, we can identify where most of the information is needed for such kind of analysis. One thing we find out is that most of the information that is available is really based on accident data, but there is very little that is really on incidents, which is,

say, for example, like near misses, and let us say, just brake failures that don't lead to accidents or collisions. This kind of data is really needed to come up with predictions of accident rates if in the future we decide to change our inspection policy, or try to upgrade our operator efficiency, and I just wanted to address the question of what kind of effort should we devote to collecting this kind of information in the future?

MR. COSTANTINO: Are you suggesting that maybe the kind of effort that goes into research on the near misses on airplane collisions might be applicable?

MR. TANG: Right.

MR. COSTANTINO: To other modes of transportation?

MR. TANG: Right, and has this been collected in the past that we are not aware of?

MR. HARTON: Well, I had a couple of things with respect to your comments, Dr. Tang. Every catastrophic accident that I am aware of, at some time or another had some indicators. These are the near misses. But most people figure they can't afford to take the time to investigate the near misses. I am in full agreement with you that this type of information is needed and would be very helpful in the preventive aspect of accidents. With respect to the prior comments, I had made a couple of notes here before we started out. In the first one I had said that information systems must be based on user needs. Then I put down, who are the users, what can be done to help the users define their needs? This is one of the most difficult things, I think, that we encounter, trying to get the person to really tell you what he needs. When you are going to get an information system started, you must know what the needs are. We need somebody to come up with what is meaningful information as far as the needs go, and how can you help the person to define these needs. There are many, many data banks available in one shape or another, and it may be just loose pieces of paper in somebody's files, but if somebody can come up with a very effective way of tying all of these systems information sources in together, I think this would be a tremendous contribution, but you don't want to get a bunch of stuff in there that is of no use, naturally.

Very little thought, really, has been given to how we can get information to the people who really need that information. I have a comment with respect to proposals and RFP's. This is a little bit off the specific subject but addresses the overall program, and that is that these proposals or RFP's should have in them a requirement for evaluative techniques and then as part of this it should include the criteria for the evaluation of the effectiveness of it. One other problem, one which kind of hits me about every other day, and that is there is a need for a systematic approach to the conversion of the R & D results into meaningful proposed regulatory actions, so this branches out a little bit beyond the immediate subject here, but these were some thoughts that have come to me as I have been sitting in here for the last day and a half, anyway.

MR. BOLGER: That last one is certainly one that we ought to be concentrating on a little bit.

MR. BURNS: I was just wondering from what Erskine said whether tying the existing data base together is the actual practical approach. Because of the manner in which these data

bases have evolved through the years, up through the modes and through shipper associations, in many cases we are comparing apples and oranges, and the data base is not something from which you can draw any definite or comparative analysis.

For example, in the transportation of hazardous materials, of which there are some two billion tons transported, we can't find anywhere, and I mean just that, we can't find anywhere a good data base from which we can make a safety analysis and we spent hours with the Bureau of the Census trying to get them to, at our expense, come up with a pilot project. We want to get some idea of the magnitude of what is being moved, No. 1, which we don't know, and No. 2, how it is being moved by mode, which we don't know, and No. 3, what is being moved, which we don't know. Perhaps we ought to be looking at a collective effort some time in the near future, to develop what the base should be and how it should be accomplished. Perhaps it ought to be a new transportation census, but these things aren't done very often, and the next time we do it, we ought to get our collective heads together and find out what we need to do the job.

MR. HARTON: I would certainly have to agree with that 100 percent, because as you say, we tried hard to get that kind of an effort started. There may be a lot of people who would say, well, we can do this, but I would put out a word of caution. We would like to have a research effort in that regard which would provide that information, but look at it very carefully before you propose to do this for us because there are a lot of obstacles to trying to get in to find out what a manufacturer is shipping and the quantities. By law, the Bureau of the Census is the only organization that is permitted to collect certain statistics, so we would welcome, I am sure, a research effort in that regard, but I only wanted to utter a word of caution so you know what you are up against, if you decide to attempt something like that.

MR. BARTFELD: I think that when we mentioned that we are trying to collect data from different sources we have access to, I think one of the problems that really requires some research effort is what is the quality of the data in the different data bases that you are going to get. It is pretty clear that you will not have homogeneous quality, so somehow or other one ought to consider how we are going to define what is in the data base so that a potential user may know exactly or reasonably exactly what is included, what is not included, and how good or how bad is it. Don't forget in addition to the census there are other people that collect the data and they are now called data bases. If you want to use them, if some idea was in it.

MR. BOLGER: You know, it seems that one of the things that we are looking for here are research proposals that would assist, in our case, the decision makers within the Department and provide us with the data that we need in that process, and I certainly would think it would be valuable if somebody came in and looked at my job and tried to decide from that what kind of data I would need as I move along in the year in doing my work. I am constantly caught in the position where I don't have the data for the particular problem. I have got all of the other things around it but not the kind that I need. I can think of three or four examples that just occurred recently.

For instance, on commuter airlines, all of a sudden the question comes on the Aviation Act about more safety in commuter airlines. We decide, since they are short haul, we would like it

on a per flight or per operation type of ratio as opposed to airlines miles or something, and the data are not there. All of a sudden I am caught off base with no data. You know, it seems that with an adequate look at the job, that might have occurred in some kind of a study.

MR. BARTFELD: But that is the kind of quality type of thing that I am trying to address. Now, if you would note, for instance, how some of the data that is in existence has been collected, you may have some idea if you can use these data, at least as some corroborative evidence to others or to samples to see if it is possible that this is reasonable.

If you have no idea how it has been collected and how good the data are, there is absolutely no way except recreating everything from the beginning, which by and large is rather expensive.

MR. TAYLOR: The problem seems to me in all of these things, I mean like your problem on the commuter airlines, to be something that is not really very predictable and if we are not careful, I will hear a call here for huge data bases. Within the last two years, for instance, I have needed data on accident rates at guard rail sections versus not, at signalized intersections having 10 accidents or more per year, at horizontal curves with various types of delineation, at narrow bridges, at lane drops of three different types, and then at complex interchange ramps. I would like to have information about the signing at those places and the marking and the accidents and it is really not realistic to expect that PennDOT can give me those data. Besides, if you had asked me three years ago, I probably wouldn't have named more than one or two of those and I would have named 12 others that I haven't had any call for.

Now, of course, I am one person looking at a very specific area, but if it is to be policy type things, like Mr. Scheffey was mentioning about where do we cut off guard rail installations and things, we need very detailed data, but I don't think that we have much chance of pre-planning all that much data collection.

PennDOT has a very extensive accident records system. The problem from my standpoint is that you can't enter it and get anything out of it. You can put lots of things into it but you can't get anything out except standard print-outs, and the data that I need actually exists there but it can't be accessed. What you end up doing is going to the district traffic engineer and saying "Where are some of these neat places," and he says, "Well, there is this one and that one," and you find that he is really the best source. I would be afraid of just huge data banks because probably they wouldn't have what you need. Somebody is going to want to know about red colored cars next year or something like that.

MR. BOLGER: Yes, I wasn't proposing that you should then develop a data base to give you everything. As it turns out, I got the data, but it took me some fumbling around in the data to find out where it was, whereas if I had gone through the logic of seeing what I needed and then matched up with available data bases around the country, both industry, et cetera, I would have been better equipped and could have responded better.

MR. TAYLOR: It may be somewhat easier, again, at a more global outlook that you people here in Washington have as

opposed to our research problems, and that may well be, but we will have trouble, I think, if you try to anticipate all of our so-called "needs and requirements".

MR. RABINS: Yesterday, after the afternoon session, I participated in a very interesting conversation between Professor Larson and Professor Tang of Illinois and Professors Pignataro and Canilli, and Mr. Mike Horodniceanu of P.I.N.Y. Professor Tang and Professor Larson are under contract to the Department of Transportation through the University Research Program to study risk analysis, as you mentioned, through fault trees and probability. It involves statistical analysis. Professor Pignataro and his colleagues are under contract to the Department of Transportation, through the same program, doing research on systems methodology studies. They were comparing notes on exactly this issue of what data is necessary. One thing that emerged from the discussion was that before one can identify data needs, and this is fundamentally important, you have to know the problem that you are addressing and you have to know your research approach. For example, we were talking about fault tree analysis for identifying the cause of accidents on highways. You can go through brake failures and tire failures and steering linkage failures, but it turns out that about 85 percent of all accidents on the road are attributable to the human factor and not to mechanical linkages or mechanisms at all.

If you want to perform a fault tree analysis for that 85 percent causality of the 50,000 total deaths on the highway, so we are talking of the order of magnitude of 40 to 45,000 deaths you are trying to attribute cause to, before you can get the data you need, you must better understand the fault tree research that is to be built up and how it relates to the human factors problem involved. Before you can identify the data base that you are going to go after and before asking how you are going to categorize it and how you are going to collect it, you have to understand what the problem is. We have here a very important cart and a very important horse; we may have them out of order if we talk about doing research on data collection or identifying the data base needs without first understanding the problems.

MR. HOSHOVSKY: That sounds like a challenge.

MR. J. MARGOLIN: Actually, this is in a sense an effort to pull together much of what I have heard in the context of experience we had back four or five years ago at the Office of Education, which was in just about the same boat with regard to audio-visual material and research about audio-visual material. They had huge data bases, a huge span of kinds of things as you could imagine, because the largest industry in this country is education. So the infinite variety of user needs was pretty obvious.

We have tried to tackle this, being foolhardy somewhat, but came up with some approximation which are very close to where you are, that not only is there the requirement that you know something about the user needs and the user styles, which I think comes pretty close to what Mike described as the research approach, but that also in the course of trying to build a bridge between the user and this fantastic data base and the kinds of things that are available so that they can be accessed, you needed as a kind of interim profession, discipline, or whatever you want to call it, a kind of translator and so for a period of time, and it is now a program that is in operation, we created essentially this discipline of user need experts who have the job

of figuring out how you help a researcher or a program developer, how you ask him questions that find out what his needs are. Eventually he learns how to do this somewhat better himself, since you provided the model. You also know how to access the system somewhat, and this was the saving grace for ERIS. Those of you who know about the Educational Research Information System realize that ERIS reached the point where the descriptors had nothing to do with what people wanted.

So the translator was brought in knowing how to define the needs. It was a procedure that did work. It is hoped that the translator will eventually work himself out of a job, that the bridge will eventually become something that the professional could do.

Now, I am skeptical about that, but as long as we can achieve the liaison, it may be worth having another discipline in the process. Two more things came out of this system, though. One was that since this is a highly effective way of learning about your entire system, if you take your bridging person and make him also an evaluator so that he can then proceed to feed back to you a picture of the system and how it functions, you have one useful set of information. The second finding, I think, was that your data base and your way of accessing it has to be a highly fluid, constantly changing, and sensitive instrument. It is very, very different from the old Dewey Decimal System with index cards that we knew in our libraries in college and in the neighborhood. It has to be a flexible system that changes as the technology changes and as the research needs change. This kind of feedback to the system so that it can remain fluid becomes critical. That, at least, is a report of what another area did with the same program.

MR. GRIMALDI: I think we are like the sultan, you know, who walks into a harem and knows what he wants to do but doesn't know where to start, and that is a great deal of our trouble in safety, particularly when we talk about research. First, we must consider that research has different meanings at various times. To those of us who like to think that we are trained in scientific research, usually this involves the development of a hypothesis first and this is where data become very important because if we have misleading data, we are going to be developing incorrect hypotheses and in this whole world of safety most of the data that we have is indeed imperfect for a variety of reasons. Just the fact that we are talking about accidents, something that I am sure by this time you know that I have a real hot feeling about, confuses the whole data base that we have to work with because there are, indeed, accidents, things that happen that are beyond the control of man and which no one should be held accountable for, and when these happen we research them or investigate them and at this point we have a different meaning for "research", to begin to learn more about this particular kind of phenomenon and then it becomes a part of our data, and from this we develop new hypotheses. But most of the cases that occur are not truly accidents. Most of the cases occur through circumstances that we know a great deal about, that we have very good controls to stem, but for one reason or another we are not applying.

Now, what we are anxious to do, in our little world at the moment, is either one of two things. For the most part, in the conventional world of safety, look for those areas that seem to be troublesome and put some kind of patch over that. Somebody with more facility with the language than I, has described this as the band-aid approach, and it is prevalent in the world of

safety. It is very practical. If we can find out where the problems are and put some kind of a guard over "that" or eliminate "this" in some way through technology, we in effect have stopped that particular problem.

This doesn't work that well, however. To wit, the airline crash at Kennedy, for example, which resulted because of the wind sheer effect, you will remember just about a year ago. The solution in this particular instance, at least the one that I read in the newspapers, was to reduce the height of the light stanchions which the airplane struck because of the wind sheer effect.

Now, that was not the problem itself. Wind sheer is a typical problem for airplanes all of the time and if you remove the light stanchions in this instance, okay, we have taken out of the picture one kind of threat to the safety of that airplane. But we have an energy problem that the airplane represents one part of, and when wind sheer occurs in another circumstance where there may not be light stanchions but something else, we will have another crash. Something more is needed in that solution, is what I am saying.

When we talk about the latter kinds of solutions, we are talking about something much more fundamental. One of the difficulties in safety that will be with us for a long, long time is that we have no discipline to work with. We have been talking about that term this afternoon and this is a very important term. Safety is not a discipline as yet. May I remind you that medicine was not a discipline until just a couple of hundred years ago either, in spite of the fact that there was some very good work being done in the world of medicine 2,000 and more years ago. Trepanning, for example, was known to the Egyptian physicians long before we ever got to the poiint where we could do trepanning relatively effectively with modern medical science, but it wasn't until people began to look into the organic system and find out what it was that the body was all about that we began to develop a discipline in medicine that enabled medicine to really perform effectively in the pursuit of its task.

Now, this kind of research, which is where I think university research should be directed, is what is most needed, and maybe when we talk about inter-modal research needs, this may be the key to the whole issue, because it is inter-modal not only within the Department of Transportation, but inter-modal with respect to all of the federal agencies which have now a tremendous commitment in the world of safety but which are working relatively independently in their special problem areas. What is needed is a harnessing of the effort that is available and it is very, very skimpy.

You know from my point yesterday, if you will remember, that universities are not able to answer this problem now. We have very few people. It is difficult to attract competent people. For one reason, if you bring competent people in today and a contract leaves next year, they leave you. You can't recover them under these circumstances. University people will not devote themselves to safety. They will spend their time in those areas where some continuity of service is a possibility for them, medicine, for example, being one area that offers that opportunity, and so we are not able to draw upon that substantial body of competent scientists.

The problem is even more critical than I am describing. The head of the Cancer Research Institute here in Washington has

resigned, you may have seen in this morning's paper, because he felt that he couldn't pursue his task respectably. One of the reasons he said he couldn't is that he couldn't hold competent scientists who were paid, for the most part, I think an average of something like $33,000 a year for their work. You don't find anybody in the safety world at a salary level of that kind doing research.

Under these circumstances, we are not going to be able to develop this discipline, this general body of knowledge that is needed, this point of view. Somebody has to make a commitment to that, and probably an inter-modal commitment, not only with respect to DOT's inter-modes, but also all of the federal government's. To the extent that we can develop this, I think we are on the right path. But otherwise, we may be just flapping our tongues and not really getting on with the problem that we want, which troubles me, because we all know what it is that we would like to do. We are sincere about it, but are handicapped immensely because of this one problem.

MR. COSTANTINO: Thank you, John. Can you, from that recitation of what the problem area is, could you define several areas that could come out of that as possible areas of research for the University Research Program?

MR. GRIMALDI: What I think I would like to do first, if I had my druthers, and it can't be done perfectly, but it would be a good beginning, I think we need a program that will enable the various research interests to create a research plan, a matrix, if you will, that will allow the kinds of research that you have to do for practical purposes, to fit together and therefore eventually come up with the beginnings of an understanding of the problem which finally one day will become literally a new discipline. That would be the first thing that I would do and I don't think that is too hard to do. As I say, it won't be perfect. If we try to be perfect about it, we will never get the thing done, but if we develop a matrix and study it continually, and improve it, we will be on the way.

This will guide the kinds of research projects that you want. One of the reasons that we are talking so much about human factors and are not getting very much in the way of projects in your offices is that we in the university see where the interest lies in government, and that is in technology. It comes through loud and clear with us. If we want to respond to that, we will, but if we are not interested in it, we don't respond. For the areas that we are interested in we go elsewhere for money if we can get there.

For example, in our areas, we are approaching the Ford Foundation and other places for funding where we think we will have more success than we have had with the federal agencies.

MR. HOSHOVSKY: I cannot comment on this particular case because you have addressed, I think, the question of what total research should be in safety and I think we are focusing on the question of data and information at this point. I would like to react to Mike's comment, who indicated, well, the situation is such that you have to understand the problem first before you really know what your information needs are and ipso facto, I assume, therefore, that we cannot predict the needs unless they occur.

I would like to disagree with you. First, we need to distinguish between needs of researchers who start with a

hypothesis, if they are good researchers, and then based on that hypothesis, they go about their research design. Once they design the research they very carefully design what data has to be collected and under what circumstances in order to have valid conclusions. These kinds of needs probably cannot be predicted at all, unless a problem statement is made first and so that is the end.

However, there are other needs and they are needs of policy makers. There are policy makers at local institutions, people who run the railroads, people who run the cities, people who run the bus systems. There are policy makers in the county and state governments. There are state highway departments. There are policy makers in the industry and associations and so on, and all of these people tend to pass judgments based on some assembly of facts. So many cars are on the road and so many people get killed from this cause. Consequently, for the policy makers, I believe that prediction can be made, providing that the policy maker is being studied in terms of the function that he is to perform or that he is assigned to perform, or in terms of the problems that he tackles, routinely tackles.

For instances, we can predict the needs of research managers, as we observe them over a period or two. We know that they are keeping track of money, of milestones, of target dates, problem areas and so on, and these needs, therefore, can be predicted. So I think this is my basis of saying that yes, needs can be predicted and the effort of predicting those needs should be made, but not in the area of research and the scientist, whose needs are basically unpredictable.

MR. BENNER: I was just going to second Dr. Grimaldi's point about the status of the safety state of the art needing a little boost. There are some methodologies that are being developed that I think probably bear a valid comparison with the development and evolution of the medical profession. I suspect we are probably pretty early into it, but a question, is the Department prepared to undertake that type of basic research to support the development of the profession?

MR. SCHEFFEY: I guess I am in a position of not knowing whether to say that I agree with all of you or I don't agree with any of you, because all of the problems that are being cited, I have been there. On the other hand, I think we have a lot of confusion going here because we are not clear about our terms. We talk about data and in one case we are talking about research information, that is, a technical information retrieval system, and in another case we are talking about data which is taken for the purpose of characterizing the system. We are talking about hard data, and I think we need all of these things. but each of those systems is a different kind of a problem, and you know, I will have to get back to my own area again, of highways, where the data problem is really in an awful mess, and it has been for years, and it is going to be as long as the people who put the primary inputs into the system have as their primary and main responsibility a completely different activity. Most of our highway data gets there from the police officers who make the investigation at the scene of the accident, and the poor man is confronted with a first priority of taking care of the injured, a second priority of restoring traffic and only somewhere down the line does he ever get around to trying to record the facts of the accident as he happens to see them.

There is also a great deal of distortion in these data because they are collected for purposes other than safety

analysis. They are collected to fix responsibility. They are collected to determine whether or not there has been a violation of law. There is a great confusion of the data picture in the highway accident scene, and I think that despite that, the data pool that has resulted has a great deal of value, because if you assume that one of the purposes of this is to take a reading on the system and find out where your major problems are, the data will tell us that much. It will not tell us how to solve those problems and it will not give us the fine-grained detail when we start getting into the kinds of questions that Professor Carter was talking about here. We have got to have supplementary systems to look into those problems, but it is vitally important that there be some kind of a general hard data base on what is happening in the system, even when we can't anticipate which direction we are going to go. This means to have a data system which at least reliably enters a certain minimal body of facts and does it in a consistent manner. I think this is getting around to the quality problem, because if the different states have different ways in which they collect this data and it is not compatible, then when you run analyses, it is not too meaningful, and we have to sort it out and run in the states where you happen to know that that particular part of the data picture is reliable. I think we have a long way to go in refining that major data base.

MR. COSTANTINO: what kind of a research study could be mounted in university research to come to grips with that problem which you have articulated?

MR. SCHEFFEY: Well, if I can be real candid, I don't think that is a job for the universities. I think there are many other places where the talent in the universities can be of a great deal more help than working with this data base problem. There are literally hundreds of people in transportation agencies at both the federal and the state level that are already deeply involved and very knowledgeable. I would rather see the universities put their talent into much more fundamental questions than that.

MS. FREE: I thought I would mention there are two bills in Congress right now about national data collection systems. One is before the House and it is an inter-modal design that would be the national collection of data, standardization of data for all modes of transportation. The other is before the Senate and it concentrates on highways only and it would be placed -- both are in DOT, but the one in the Senate would be placed in NHTSA.

MR. ROLAND: I would like to make a comment about evaluative systems. Out at Southern Cal. we frequently interact with safety specialists from agencies other than the government, and also from government agencies, who have to allocate their scarce resources among a number of disciplines, one of which is safety, the others of which pertain to the more operational aspects of the system. They are, of course, always faced with presenting their case for more safety in terms of common criteria which then the upper level managers can evaluate and decide how much safety is enough for their organization. I would like to suggest both, of course from the data base, but also from the point of view of evaluative systems, that we see a very strong need to put safety into the game with all of these other people, all of the ill-at-ease, and all of the traditional decision methods by which we have been evaluating whether a system is balanced across the board in all of its operational aspects, to

be able to throw it in there and compete for dollars in safety. I fear all too often in the past, particularly in industry, the safety man comes in and says, "In the name of motherhood and safety give me some resources," and that is just not enough anymore.

MR. COSTANTINO: Thank you. Chuck, do you want to elaborate for just a second on your thought that the universities should do some things in regards to data and not others? At what point do you make that cut-off. What should they be doing and what should others be doing and who are those others?

MR. SCHEFFEY: Well, I guess what I was really saying is that I think there are other places for their talent rather than getting involved in the national data systems. For example, we have sponsored some work on the basic problem of the information loading on the automobile driver as he proceeds down the highway. To what degree does this information loading from signing, from delineation, from the clues he gets from other vehicles, to what degree does this information load sometimes become so overwhelming that he misses the critical cues. The small investment in that particular work showed that there were situations where signing systems that normally are very adequate and which have been shown up in test of the human factors involved were the proper way to go, completely failed, because the information loading on the driver is simply overwhelming. He gets too much information and he can't process it fast enough to take appropriate action. Okay, what comes out of that then is a deliberate effort to spread the information load along a longer length of highway so that he can absorb it properly. That was pretty fundamental work in the human factors area of signing. We need a lot more of that kind of work because we don't have general theories about this information loading which are well documented and which have universal application. You know, to say that we haven't sponsored and attempted to develop talent in this field is simply not correct, or to say that we don't have a matrix in which we are working in trying to close the loop on a lot of these problems. We have a program, but we do not have in that program some of the longrange fundamental work that we would like to put there for the simple reason that Congress demands immediate outputs. Our bosses demand immediate output. The public demands immediate output. The hope I have always had for this university program at the Department level, that this would be a place where some of that pressure for immediate directed research could be removed and we could lay a solid base for future applied work, and I come to this conference and I find that one of the criteria that you are talking about, shortrange outputs, three years. That is not longrange fundamental research.

I am sorry, but I am at odds with my 10th floor associates on this. I think if you really want this university program to be productive in the long run, you have got to give it the kind of support that says, "Work on these fundamental problems, lay a base for a better attack on these problems in the future, and we are not demanding that we get immediately applicable results in three years time."

MR. BOLGER: I don't know that three years was really the target. I just say that was certainly mentioned, but we are talking three years and beyond and saying "However, don't forget that there are immediate problems, but that the major thrust must be in the longer term." I don't think that we disagree with you on that, Chuck.

MR. SCHEFFEY: In our own program, which is presumed to be highly applied and shortrange stuff, we have made an analysis of our more successful projects from the time they were initiated in the budgets to the time we got them deployed to 50 percent of the opportunities in the field and the minimum time on some of the more successful projects is about eight years.

MR. BOLGER: Well, if you read a little further in the fine print that three years starting time is after all of that initial effort, so that we are talking about the same thing, the seven to eight year, the 15-year type of thing, as the close term and then further on for longterm.

MR. SCHEFFEY: Well, in things like motivational research, things like modifying risk-taking propensities, areas like the information loading I mentioned, I think you had better plan on a long haul before you get results out of this that are going to provide a good solid base for future work.

MR. BARTFELD: One of the areas here that I think is very much in line with this is the lack of communication that really exists between people trained as engineers and mostly concerned with safety as one part and people in the behavioral sciences. I think it came across yesterday sometimes quite clearly, sometimes they used the same words but don't use the same meanings. There are very few research efforts, and they surely have to be longrange research efforts to put the things together, so we very often do not know the kinds of data that may be needed for a problem because we don't know the order of magnitude that really should be included in the system. I think these are some of the longrange plans and I think you are quite correct.

I am not quite sure that we have, really, vision enough at the moment to see how we can circumscribe some of the areas to make meaningful arrangements for the future, because I don't think we know basically enough about the inter-connection.

MR. DARLING (TSC): I have been sitting here listening to this discussion and it appears to me that one of the key issues hasn't yet been assessed and that is the poor guy who is going to analyze the data is often not brought into the whole picture until the engineers have decided, "By God, we need some data to solve this problem and let us go out and set up our instruments," and then, "Well, maybe we ought to get hold of an analyst somewhere and see what we are going to do," and he looks at the experiment and he sees, "Gee, you have got everything except the vital information that we need to solve this problem." The timing is not right or they only took it at one side rather than two, we don't have a baseline and so forth.

For instance, in traffic safety, the fatality data that now exists are only for a year and a half. The automated fatality data that has been collected by NHTSA under their fatal accident file program is only for the year 1973 and half of '74 and it is only about 75 percent complete. Here we are in a highly technological country and we have decisions to be made and we have studies to be made that need some kind of an historical perspective and you can only go back to 1973. That is a little discouraging. We found this when we dug into the data during a recent analysis of the effect of daylight saving time on fatalities. I would argue, first of all, for a continuity in the collection of data. Don't just drop a program or modify a program. For heaven's sakes, keep it going.

Secondly, recognizing the tremendous expense of data gathering, get some bright analytical types in at the beginning to tell you how much data to collect. Do you need data on every accident that occurred in the United States, or can you set up a judicious sampling program that will allow you to collect maybe 20,000 properly selected accidents which will give you the representative statistics? This is a very vital issue that bears on whether this kind of data gathering activity can continue over a period of years.

MR. BERKHOUT: I wish that the source and the quality of the data were mentioned more often when reports are being written. Now you just came up with an item that fatal accident data on a monthly basis goes back to '73 and they have only got it for 18 months, but I have seen a lot of reports that talk about fatal accident data, both before and after. Obviously, they are talking about different data, but it is not clear where their numbers came from and what quality they are, and just getting the imprimatur of one of the Department agencies on it doesn't tell you very much either, because that might be two or three different sources of data of different quality.

Now, on the hand-out tables yesterday, there were tables of monthly fatal accident data for 1973-74, and '75 without any indication of what computer it came out of or how that data is different from the data you are talking about now, of which only the 18 months exists, and are the 18 months that are the same, the same, or is this data from some other pot, and just looking at the report, there is no way of telling.

MR. SCHEFFEY: Let us not forget that there are 50 states involved in looking at traffic accidents and have been for many years, and many of their data systems go back a great deal more years than the one we now have in the federal government. So when you look at what is in that one data base that has only recently been automated, that doesn't mean that it is not possible to go to other data bases to look at some of these problems.

MR. BERKHOUT: I know that and we have a graduate student in our school who is doing a thesis now on month-by-month fatal accident data. He couldn't get what he wanted for nationwide data, and is doing it on data for the State of South Dakota, which does go back, but it has to be searched partly by hand, and it takes a little more effort to get it and it is less of a base and fewer numbers. But you are right, there are numbers out there that you can get your hands on.

MR. BOLGER: There is another problem there too. Every time I look at this data supporting someone's conclusions, my first reaction is what is this guy trying to prove? How did he bend this around to get the answer he wanted? For instance, the highway people want to make some more roads, right Chuck?

MR. SCHEFFEY: No, that is not the main goal of the highway program.

MR. HOSHOVSKY: I agree with Chuck partly and partly disagree. I believe that he is right to say that the university talent should not be diverted to building data bases and data systems and getting involved in national systems, per se, but I do believe there are areas where the university talent could be brought to bear upon the problem, and I look at this panel discussion list here, and this is the only source of my inspiration at this moment. For instance, I think the university

groups are capable of defining portions of the requirement of the selected group of people, let us say, city managers or whatever they are, so this would shed some light for the policy makers or for people who build systems as to what is the characteristic of requirement in some particular section of our transportation economy for data, that is.

Secondly, on the analytical tools and techniques, I believe that there is an area where the university environment is rather suitable to speculate and refine various analytical methods to deal with data that may not have been practiced so far. Third, I think that the university programs could engage in the area of developing the concepts for measures; how do we measure the transportation system fatalities? What are the data points that ought to exist in order to have meaningful measures?

MR. LOFGREN: One of your questions here is what are the requirements for data collection, data definition, storage, retrieval, dissemination, and use. What are the requirements for that. There has been some discussion of that. There has also been some mention of some available data systems, some incomplete, but there are some others that have not been mentioned. There is data available in North Carolina, because of the nature of its accident reporting system, data that there is not available generally. The Highway Safety Research Institute at the University of Michigan has some unique data sources. Calspan has some unique data sources. There are the results from the MDAI teams that NHTSA has.

Wouldn't it be useful to the university researchers and the safety community generally if there were a single document that described these available sources, what they could tell you and what they could not, so that persons whose data needs, whose research can be met by those systems will know that they are there and can be utilized, some by computers, and this in turn should also make it, should help identify data needs which are not now being fulfilled at any source?

MR. LARSON: I would like to echo that would be very nice to have. I think in our efforts so far we have found those various sources by many different methods. It would be a help to anybody to know where the sources are, and then be able to call upon them as needed.

MS. MISCH (George Washington University): We have been talking about different kinds of data here, really. One of the kinds of data that it seems there is a crying need for in safety is attitudinal data and there is a particular problem there. A great deal of what exists comes from surveys. Sometimes they are in person. More often they are telephone surveys. They have this particular problem, that the information is gotten under relatively superficial circumstances. Someone calls you up, you are asked to answer a few questions, that is it, you are one of a thousand people who are sampled.

One of the things that I think universities could help with and that we need more research on to improve the data base is some way of cross validating this kind of information. Surveys are very useful because you can, within some sort of manageable budget, get a sampling across a wide range of people and a great number of people, but they do need to be cross-validated because of the peculiarly superficial nature of the data gathering.

Now, there have been some steps made to cross-validate the in-depth kinds of interviewing and it doesn't have to be

carried out as extensively as the surveying, if it is very carefully designed, but I see a great lack of this in the attitudinal data base, particularly in relation to transportation. That it is something that a good deal more research could fruitfully be applied to. We need to develop more cross validation methodologies.

MR. J. MARGOLIN: We do something that is a little arrogant sometimes in using surveys. Surveys are things that we design. They are limited in what they contain to what the researchers believe to be important and they don't open the universe that the public, that a sample may have to give us, so that one of the elements of cross validation that Marian was talking to is opening the possibility that your sample may be able to introduce you to a few areas of concern and a few facts that you hadn't anticipated in designing your survey and which you may not find out until well after your survey is en route.

MR. TANG: It appears that the whole discussion so far is based on hard data, solid data, but it seems from these two days of conference that a lot of information that is lacking is really human factors and things that it seems is very hard to get data from. It appears that the subjective information, based on judgment and experience, and how to really extract this type of information to give probabilities would probably need some efforts in the future.

MR. RABINS: To take your comment one step further, Alex, I think you are right, and you are also right, Chuck. It is like the judge who hears one side of a case and says, "You are right," and hears the other side of the case and says, again, "You are right," and the clerk says, "How can they both be right?" The judge says, "You are right too." I think we have a good example that most of us have probably heard about. Professor J. Forrester of M.I.T. has been very much in the public eye recently because of his work on limits to world growth. Questions of validation and data gathering are very frequently raised concerning his work. He has a fundamental point of view which I think supports both of your statements. From his writings and his models we conclude that we should probe for the basic causalities and contemplate and investigate the fundamental problems, such as the example you raised, Chuck, of the information loading. We must first try to understand the basic issues involved and then develop the mental, or mathematical, or computer, or tabular models that we can use to make better decisions and better plans in the future.

But the point where he is most vulnerable in his presentations is when it comes exactly to the issue that you are raising, now, Alex, about the needs for data and the validation question that you raised, Marian. We must have the data collected to support the hypotheses that are being made so that we can use them with a reasonable level of confidence to go ahead and plan intelligently.

But I think I tend to agree with Chuck that the role of the university researcher is predominantly in the contemplative mode of trying to understand the fundamental issues that are involved that the governmental policy makers and industry have to act upon. Those of us that are in the universities in the research area mainly have to confront the fundamental issues, the longrange basic issues, and try to understand the causalities. Data gathering and validation is, of course, part of our job, but the No. 1 issue must be to understand the causalities.

As in the example that we discussed last night: how do you understand the 85 percent human factors causality of all accidents on the highway?

MS. MISCH: Can I just say one thing, and that is I don't see how you can separate the two because you can't really make any headway in understanding causes and helping to predict future happenings without being able to be firm or to be clear or sure about the validity of the basic data and I give you only one example. For centuries, we validated with each other that the sun rises in the morning and the sun sets at night, and that seemed to be a perfectly well validated objective, two pieces of data. I think we think a little differently today about how the planetary bodies move, but a lot of bad predictions were made on the basis of the sun rising and setting.

MR. LOFGREN: If it considered the role of the universities with respect to data, shouldn't someone comment on the role and responsibility of the Department of Transportation with respect to data sources? I just pose the general question. We have been discussing the responsibility of universities with respect to data collection and analysis and so forth. Is there some statement of the responsibility and the current activity of the Department of Transportation with respect to this same subject?

MR. COSTANTINO: Mr. Lofgren, I think as I understood the conversation up to now, it was not necessarily the responsibility of universities vis a vis the responsibility of the federal government, but it was more or less trying to define some proper, appropriate research areas that universities could work in and I think what I have been hearing is that some of the very near term kinds of manipulation of data are probably not fruitful places for them to spend their efforts, but they might spend their time on more fundamental kinds of research that really have pay-offs in the longer term. Would that be what you said, essentially?

MR. SCHEFFEY: Well, I guess I have got my neck out here, but really I think the universities can and should be involved in methods of analyzing these data and innovative ways of going about dealing with the data. My stricture is against having them involved in the data collection process. I do not think that the universities should be the people who take the responsibility for designing and maintaining the data collection system. I think the best contribution they can make there is when working on specific problems they find that the kind of data that is present in the system is defective, to tell us how it ought to be changed, and in that way influence the data collection system.

I didn't mean to say that they should not be involved in any way in influencing the way that data collection is handled. One example of how short we are caught is that we are all aware of the fact that since the 55 mile an hour speed limit has gone into effect there has been a decrease in highway fatalities. However, there is something very spooky about this because the reduction that has occurred in the urban areas where the speed limits were already below 50 miles an hour is a greater percentage reduction than has occurred in the rural areas where the speed limit went below what was previously specified.

Now, really what we are having a desperate time trying to separate is how much of the reduction we are seeing is really

a result of that change in the speed limit? How much is a result of the reduced travel that resulted from the petroleum shortages and the increase in gasoline prices, and how much is due to the final beginning to take hold of some of the safety measures that had been applied? We can, in isolated cases, lay claim to some of that fatality reduction on specific safety counter-measures, but we really can't separate the whole picture and say how much of that has resulted from the efforts of, say, NHTSA that has come to fruition after five or six years of pounding, how much is due to specific counter-measures that have been applied to the design and construction of highways. It is all very fuzzy and difficult to sort out and we could sure use some help at that point.

MR. BOLGER: My one comment, though, deals with the point you make about safety data. It is an interesting one because ultimately the researchers come back at us and ask for data to do their job in a lot of cases, which you are doing now, right? As a result, we had looked at safety data within the Department, all of the modes, a couple of years ago, and there are like 68 data bases that deal with safety of transportation, ranging from file drawers to fully automated. The highway I guess and FAA have the more elaborate, the better systems. The railroad is coming on very strong with their new system but they didn't really have too much before. Transit doesn't exist. NHTSA is trying to get a handle on a data system and they have been doing it for a couple of years and I don't really know where they stand now, but that is really in the growing phase, so it is of varying qualities, depths, and existence, stage of existence, and it is not good.

MR. FOLEY (Federal Highway): I think that we, as the users, have some responsibility to ask the questions that need answers, and identify the data that would, we think, provide us a start on it. Time and experience will modify that, obviously, because we don't know where we are in a lot of cases.

MR. BURNS: I can see a role for the universities in this area. We have really a mish-mash of data we have talked about in transportation. As I say, it has evolved because of the manner in which the modes have grown. They have grown at different times in our history. We refer today, for example, to the Trends magazine of the American Trucking Association. We refer to data that comes from the Association of American Railroads, from the Air Transport Association, and the Transportation Association of America, and we quote these figures, the quality of which is unknown, as Dr. Bartfeld alluded to before.

It seems to me that we could put some research into the manner in which the data is arrived at, what formulates the data base, what duplications exist, how meaningful are the figures, what quality exists within the figures that are quoted, things of that type.

Now, let me give you an example. We see today a figure of some 2 billion tons of hazardous materials being transported per year, quoted by Vic. Even the associations have picked it up, quoting it before the Congress. That is a figure that I personally pulled out of the air. I have gone to many organizations, including the Bureau of the Census, and no one really knows how far off that figure is. It could be one billion. It could be three billion. I am talking quite candidly now, and it is a sad state of affairs when the people in the United States are talking about a data base and can't really tell you what is happening in the transportation business.

MR. HOSHOVSKY: The question was asked what the Department is doing, or what it ought to do. I know what the law says it ought to do. The law, a Public Law, says that it ought to collect and disseminate all kinds of information, so there is no doubt the Department has a statutory responsibility to the public or to the industry and to Congress to do something about it. Now, the Department has done something about that thing. It would be unfair to say that it has not been doing it.

For the study of safety requirements, safety information requirements and data and statistics and identification data bases, there was a project called TRANSIS. Unfortunately, it died, sort of a quiet death, for lack of funds. Lack of funds, I would say, has come because I don't think anyone was knocking on anyone's door saying we need more and better credible data. Funds were needed for other things. So this one died, but it didn't die completely. It carries on.

The Secretary himself, in his policy statement, has pointed out that data is something that he is very much concerned about. He has a committee now going on trying to find out what the Departmental needs are and how they can get at it. The Transportation Systems Center just has come out with an analysis of the data bases that are available and have been used for policy making and so on. That paper is a working paper, but probably might be made available.

Efforts are being made at inventorying data bases, models, computer programs, and other kinds of things, including my own program that you have seen to try to bring about an information access system to such data bases as those created by the Federal Highway Administration or the Transportation Research Board at universities, and so on.

We are investing money in tools whereby we can provide access to these data bases, because unfortunately, many of them are computerized and the only way you can access a computerized data base is by some mechanical and electrical device. There is no other way of doing it. Finger poking will not do any good. So efforts are being made there, and I think that if you look at what the Department is doing, there are even substantial resources going into it. I would pull a figure from the air too, and I would say that approximately $30 to $35 million each year is being spent by the Department to either create data bases or massage that thing or distribute it and deliver it to people.

Unfortunately, now, I will give the negative side. The negative side is that the effort is not integrated. It is a typical situation of do it yourself game. It is sort of like we are a big tool rental shop but you have to mow your own lawn, buy your own gas, and this is what is happening. The resources are not being integrated sufficiently to make a difference, so each operator does the best he can with the resources that he has. This area has not been really studied; namely, the efficiency of building, creating, and maintaining data systems. I would say that this is an intellectual effort and maybe universities would like to tackle it.

MR. RABINS: I had a question for John but I would very briefly like to comment on Alex' remarks. There is a technology sharing program in the Department of Transportation, in the Office of the Secretary, that was referred to yesterday, under the direction of Mr. Linhares. I know that Alex works very closely with him. Of particular interest to those of you here

from the universities and those of you who will be reading the record for future perusal, is the fact that last year for the first time the TRIS on-line system was referred to in the solicitation booklet that went out from the Office of University Research. This coming year the intent is to have the TRIS on-line system referred to even more explicitly with some specific direction of how universities wishing to propose in specific areas are going to be requested to go to the TRIS on-line system to take advantage of that system, not just for data and data base, but perhaps more importantly, for research bibliographies and to find out what research has been going on and is now going on.

A question, John, to you. As you know, in our conversation yesterday, you intrigued several of us with your remark that 90 percent of occurrences are what you choose not to call "accidents". I wonder what we call them now. I am at a loss for a word. To pursue that for a second, if we somehow or other put together a data base and achieve an understanding of the data base, might we be able to predict and avoid those 90 per cent of "occurrences", perhaps by using mechanisms of the sort that are being researched at the University of Illinois or Polytechnic Institute of New York, on fault tree analysis? Can you be more specific about what research needs might be appropriate for university capabilities? Can we use the matrix that you were talking about for going after those 90 per cent of "occurrences" that aren't accidents and be able to predict them and do something about them?

MR. GRIMALDI: First, I want to qualify what I am going to say. My work has been done largely in industry and that is an advantage because we have a homogeneous setting. The trouble with safety people has been that they have been trying to find a common remedy for the problems that confront them and usually there is no common remedy when you are dealing with a whole series of variables, such as you find in transportation work, whether it is on the highway, the railroads, or whatever. Railroads and aviation are special, and if you have homogeneity there, you have a chance for doing something along the lines of what we can do in industry. With that qualification, let me proceed.

Let me touch on data for just a minute, which I should have spoken on, I suppose, a little bit more fully when I asked for a chance to speak earlier. The collection of data for the sake of collecting data is probably in many instances going to be fruitless. We have to have information that is going to give us something that is not only factual. This is why I get upset about accidents and those unwanted events that result in harm of one kind or another. If we look at so-called "accident data", we could see a clear description of whether or not there is indeed something occurring in these events that should have been identified and could have been controlled, and therefore, could have been predictable. This is where the notion of prediction begins to emerge, I hope.

In other words, if I am right and I have looked at data in a variety of ways for some 35 years, in a variety of kinds of instances, in about 90 percent of the cases, the events that are troubling us occur from conditions that we know a great deal about or acts that we know a great deal about, and where we have already established controls that would have taken care of those particular issues. The trouble is that we don't get the applications. Now, if the applications are of one kind we get the accidents. It is inevitable that that kind of event is going

to take place, and under those circumstances I say we can't talk about "accidents" because what we are doing is losing sight of the fact that there is a responsibility for performance with respect to controlling those particular kinds of conditions. Culpability, which is a very important issue when we talk about control, is completely ignored under the circumstances. The term "accident" becomes excusing and the whole notion of going on with our problem begins to get lost.

Okay, now what have I done, to answer your question? My own work has been concerned largely with looking for those things in relatively homogeneous settings. These are industrial settings where controls can and should be exquisitely maintained in terms of the quality of the effort. If I find that those controls are not in place I say to the people that I am doing business with that it is inevitable that whatever it is in the system that could happen is going to happen and under these circumstances, you have a responsibility for doing what is necessary in order to bring about a change.

Systems analysis provide some of that kind of information. I think I, with some modesty, can take credit for systems analysis even though nobody knows this, when we were bidding on the Minuteman missile at GE, we wrote in the very crude, but the first, systems analysis for the determination of, and then the requirements on the Minuteman. The contract went to Boeing under some DOD decisions with Boeing being given the opportunity to go beyond what we had been suggesting and out of their work came the fault tree analysis and the whole world of systems safety began to grow. The trouble with systems analysis is that it is very costly to do. There has to be an issue that is immense enough in terms of a homogeneous setting which is the point, that makes it worthwhile for this kind of investment. When we did systems analysis at GE when I was there, on such things as the jet engine, for example, we would rent the local gymnasium and the fault tree analysis charts would go on butcher paper all around the walls of this gymnasium as we worked out the details of the system, and the number of man-hours that were involved in that is tremendous. You can't do that in every kind of operation. You can do it in aviation. You can do it in railway operations. But when you talk about highway systems and all other parts of the transportation problem that involve the motor vehicle, now we have an issue here that largely is beyond us and probably will be fruitless as we come to whatever conclusion we are going to reach after we have made this kind of analysis.

Maybe that is not the best way for this particular kind of problem. Some other ways, perhaps, are available to us, but I don't know what they are. Perhaps we ought to be submitting some proposals to you to get at that. What I am afraid of, though, in answer to your question, is that if we talk about those kinds of approaches, they may seem so esoteric that no one is going to be very much interested in them since, as has been said, they would be rather longrange in terms of product. In order to have them of any value, they would have to be validated, even after we had done the research and collected the data on the basis of our research, which is another part of the data collection problem.

You don't get the data from the events that are taking place. There is a lot of data that has to be acquired on the basis of experimental research and that has to be validated along the line to be sure that what we are offering to you has some concrete possibility of doing some good. This takes time and it takes money, so when I think about prediction, I am talking about

those kinds of analyses and then the acquisition of that kind of data that would come from those analyses that enable you or me, with some assurance, to say that as long as this circumstance exists this way, it is inevitable that the unwanted event and so much harm, which we can give dimension to, is going to occur. Then, at that point, we can establish the responsibility and if things are not carried forth, the culpability, for the event that occurs. As soon as you have established culpability, you have got the beginning of control, because no one wants to take the chance of being found negligent in the fulfillment of his responsibilities, particularly in high level management positions.

MR. COSTANTINO: Thank you. Would that answer your question, Mike?

MR. RABINS: I think except what you call "the other 90 percent of events".

MR. GRIMALDI: Well, those are the ones that are predictable.

MR. J. MARGOLIN: I think I am going to get in trouble with this, but I have already started out on the wrong foot with Mike with the comment about the one-page proposals but let me try another one, about something that the universities may need, or indeed, any other external research operation. We know and you know that an awful lot of our stuff ends up on the shelf. You work two, three, even four years. Somebody accepts your report. They say you have satisfied the contract and on the shelf it goes and into your bibliography it goes, in your data, and so forth, and maybe somebody will access it someday.

One of the things that we can use is feedback as to significance. A lot of what we do is supposed to have policy implications. We generally will be given a contract or a grant. We will work on something for a number of years. The monitor who is appointed is usually somebody pretty good but likely to be somebody pretty far down in the system who, in order to get any feedback, has to go through three or four different echelons. A lot of translation takes place, if indeed it happens, and we don't really get anything that tells us, A, are we on the ball and B, should we be changing in any way, before the product is completed?

I guess what I have wondered about is, is it ever possible, is it within the realm of any kind of imagination that a study, let me just set one up for a moment, in which economic and behavioral issues were studied in an inter-disciplinary fashion so as to design a new or at least modified methodology but having a third component in this interaction between the economist and the behavioral scientist, just to use one illustration, that third component being somebody high enough in the Department of Transportation or the Department of Housing or wherever, who has some policy responsibilities, and who can begin to give feedback to their researchers with regard to what you can already see that I am shooting for, the significance, the relevance, the meaningfulness, the credibility, if you will, of what the researchers are accomplishing.

It seems to me that at least the interspersing of this, like, on every 10th project or every 15th project, might begin to inject into the academic community some of the thinking, some of the needs, some of the style and the requirements of the policy makers which we then might begin to give to others.

MR. RABINS: That is a recognized need which we perceive in the office now, Joe. We are undertaking some first preliminary steps in that direction. For example, in the contracts that are being written this year, the new contracts, for the first time we are setting up, as part of the contracting responsibility of both the monitor and the principal investigator, the establishment of a directory of users, an advisory board for each contract, drawing on both people within and without the Department of Transportation. That would also be a mailing list for progress reports, for final reports, for opportunities for interaction, and that would be the people that would be involved in the oral briefing for argument sake. That is a first halting step in the direction that you are indicating.

We are also trying to undertake closer ties with Al Linhares' effort in technology sharing, again, to close the loop on your research so that it is being implemented and being used.

MR. J. MARGOLIN: But the other thing I wonder is if you will please make arrangements up there so that we can hear what you are saying?

MR. HESS: You have to give grants to do this, but it is readily available to you from the document ordering service. It is readily available how many orders there are for your particular research reports. We look at that regularly. The other thing is a citation of your reports in the scientific and technical literature. We look for that regularly; then lastly, the citation or referencing of your past research in DOT RFP's, all of these things, as I say, you have to have a certain amount of bravery to actually deliberately openly look for such data, but it is useful.

MR. RABINS: Well, there is one indicator that unfortunately is not available. You can find out how many orders for reports there are, but you can't find out how many times TRIS on-line has been searched for your report.

MR. HESS: No, but you should be able to use it, though, on all of our on-line nationally available data systems we have had the automatic record of the file which is called, so it must be within just some stretch from where you are to have that available to you.

MR. SCHEFFEY: I am not sure we are really addressing, in talking about how many copies of the report go how many places and how many times it is referenced, the kind of responsiveness that this gentleman is talking about. If I am not mistaken, what you are saying is if you give us what you think is a solid body of research that shows that the policy as is now being carried out, is not appropriate, and there are recommendations for how it ought to be changed, where you get your feedback to know whether anybody is paying attention, is anybody listening?

MR. J. MARGOLIN: Yes, it doesn't even have to be something as direct as a policy document, although that would be ideal, but even something with policy implications that we might not even be able to see directly from where we sit, because we are pretty much removed. I am here in Washington. I spend a lot of time with DOT people just because of the convenience, and over lunch I learn a few things that may be important to somebody in his job, and I think we are obviously atypical.

Now, the situation that you describe is the most critical and if we could get that, that would be tremendous.

MR. SCHEFFEY: Well, I will guarantee you if you do a contract for any segment of my office, you will get it. You will get it and you will get it not at the time the final report is fied, but during the process of progress reports and at the time you send in the draft report. We had a little discussion here earlier today which was, I think, an instance where there was some feedback, very critical feedback, because we felt that the work had not been conducted with a full view of what was necessary.

Now, it isn't always that kind of feedback. We have, in our particular organization, placed a great stress on the implementation of research and development results. In fact, we pulled, four years ago, about 25 percent of our research staff out of the research function and put them internally into the job of seeing that results got implemented. There is a great deal of interaction between our contractors and research contractors, whether they be university or otherwise, and the customer offices, who were supposed to make use of that result.

In many cases, of course, the work that is being done is of a longrange nature, and there are no immediate policy changes, but there is at least an appreciation of what the implications are. Now, we are trying to furnish that same kind of feedback where we are monitoring university program studies in Dr. Rabins' office, and I think we are not getting as far, maybe, as we ought to be, but we are furnishing it on those that we are monitoring.

MR. RABINS: Well, the program is only a few years old and it is getting established now to the extent that what Chuck is describing is happening. It is becoming part of the initial reviewing process of the proposals to ascertain in-house need before they are ever funded for contract work. Namely, to identify a monitor that really needs that work and is going to pay attention to it and is going to interact in a way that will do you good and give you feedback and make sure that your results are used and implemented.

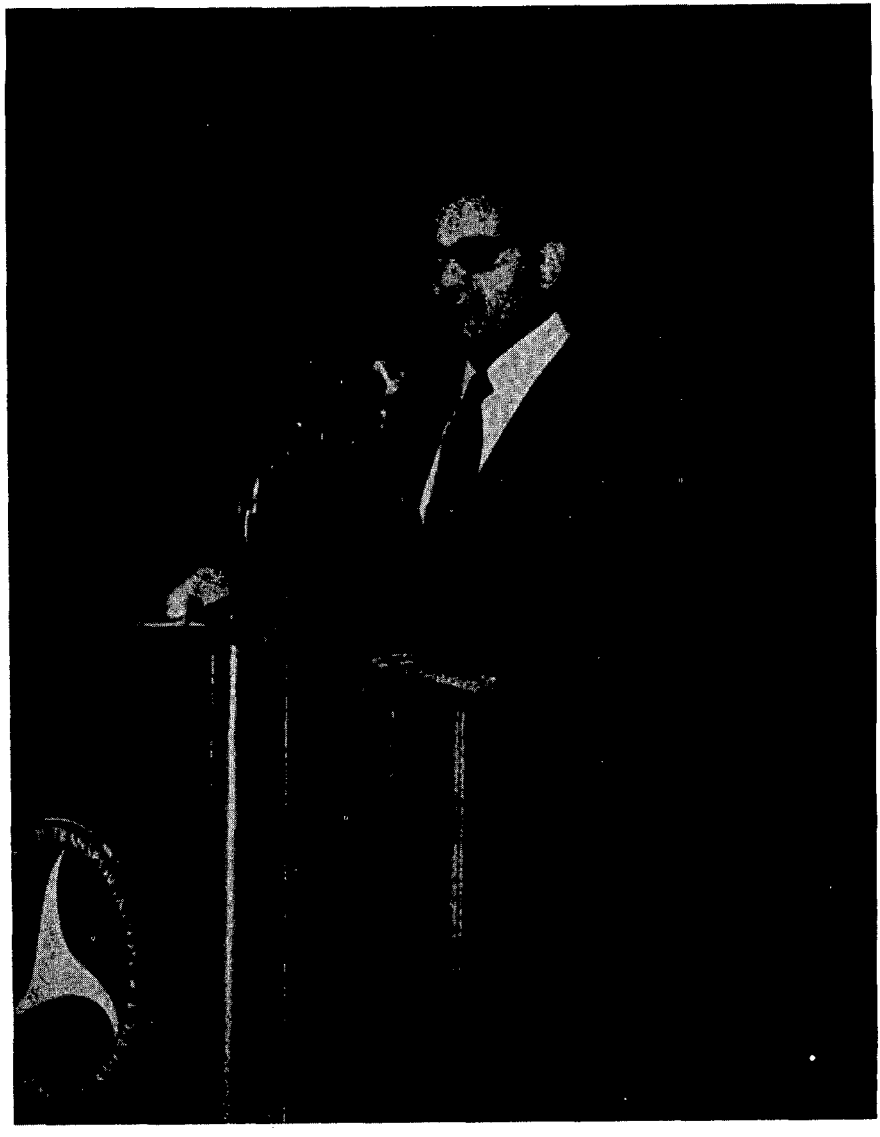
MR. COSTANTINO: Dean Taylor has a final comment, if you don't say anything that is controversial.

MR. TAYLOR: Well, I want to say that our work is through Mr. Scheffey's office and we have had that very experience in this last contract. We asked for a review about midway and said, "Now that we sort of understand the problem better ourselves, since we are into it a year, should we go this way or that way." They set up a fairly extensive meeting and called in people from states for us to say: "Should you go A or B?" Finally, we were in Mr. Foley's office for something and he was concerned, I think, more about how it might or might not result in some kind of policy statements. You can pursue it yourself as well as being called.

MR. COSTANTINO: Fine. Thank you very much. We must now bring this to a close. Just by way of a very, very brief summary, although I don't think it is possible to summarize a discussion of this type, I think we have explored a number of problem areas that are fruitful for possible university research. We have said that it is impossible to talk about needs without figuring out what the users need. We definitely need good data.

Safety, it was said by Dr. Grimaldi, should be a discipline, and a systematic discipline like medicine, and it is important that the researcher needs a research plan in order to get the big picture.

But we may have a definition problem in that as far as university researchers are concerned, the national data system and its manipulation may not be a fruitful area for universities to work in, but universities should be working in longer range, more fundamental problems and trying to straighten out the data that we are currently using but not to manipulate that data. Thank you.



DR. JAMES COSTANTINO, DIRECTOR, TRANSPORTATION SYSTEMS CENTER

CONCLUDING REMARKS

MR. BOLGER: We will just summarize a few things and then we can call it quits.

MR. RABINS: We have had a recent conference somewhat similar to this about a month and a half ago. We had a two-day conference at the National Academy of Sciences to try to define priorities for university research. We had a somewhat similar group, perhaps a bit larger, and perhaps a little bit more diverse in its particular immediate interests. The tape transcript of the meeting amounted to about 200 pages. At the conclusion of that meeting we really didn't know what we had. We are still scratching our heads a great deal, but we are beginning to learn something, having gone through the transcripts several different ways and several different times. I can assure you that the same thing is going to happen here.

By going through the transcripts very carefully and having a number of people doing this, and by comparing notes and using different perspectives (using something called the KJ technique -- maybe I will whet your curiosity -- that is a Japanese technique for going over a mass of information and trying to categorize it by looking at each little data bit on an index card and trying to organize it in matrix arrays and see what patterns emerge), and some amazing patterns emerged. Some very, very clear messages started emerging from those two days of discussion by about 150 people, discussing broadly the questions of priorities for university research. I am sure going through the same exercise with this tape transcript, within the narrow confines of safety problems, that again patterns will begin to emerge. You can be assured that those needs and those patterns will show up in our solicitation booklet this coming summer.

So I want to tell you that this conference on Intermodal Safety Research Needs was, from our perspective, a very important one and one that will be utilized. I promise you diligence and effort on the part of everyone that we work with in our office and that helps us in utilizing the results of your discussion. As the patterns emerge out of the study we will solicit your efforts in a way that we hope will help us and you. We will do our best.

MR. BOLGER: I think you have said it all. I just have one further comment. As the safety professional in this duo, my job is to get from you some proposals which will assist us in our very real problems. We tried to outline these to you starting from the modal perspective and then going to the Departmental perspective. We need to get those interdisciplinary or intermodal kinds of proposals that we can really use. I can also second what Mike said, that we are going to look very, very carefully at this so that when we come back to you we will do a better job of explaining our viewpoiint to you concerning what we are looking for. I think that has been part of the problem in the past and I feel that from what we got these two days we will be able to do that.

The extract statements from the Secretary's policy* are something we all ought to look at very carefully when we are thinking about safety. As I looked at it myself and thought about what we had been talking about here the last two days and what my problems are, and I can see about five areas that emerge.

*Appendix 2 of the Conference Guidelines.

The first one is the very real one of the effect of regulation. This is a very large and national problem. The President has put his attention on it. We have been directed to do something about it, and we need the tools to be able to tell us what these effects are so that we can regulate in a more orderly manner and not perturb the system in ways that have occurred recently, and I give you the example of the 121 brake system.

The second area is the measurement of performance. We must be able to develop methodologies for that very important aspect of our safety activity. We need to know what tools are needed to measure the performance of our safety activity, in our regulation, compliance, and enforcement actions.

Third is one we keep coming back to every time, and we can't do the first two without it. That is data. We must get a better handle on what our needs are, or as you have said, our requirements.

The fourth area that keeps popping up is the planning and management processes that we use. I am going to include in that the input to the planning process of the consumer or the transportation user. How can we use that in a better way, a more effective way, to have the user and the public understand safety problems and participate as we do move forward in our safety activities?

The final area relates to human factors in safety. Somebody said it once and I don't remember who it was, "When you get a bunch of engineers sitting around, the human equation side seems to get lost." There is a very real need to integrate the human being in the safety equation.

Those are the five general areas I have seen popping up in this conference. I saw them in the extracts of the Secretary's policy. I know we need them. We will try to enunciate that better to you in our solicitation, I will look for some efforts in those areas from you.

MR. RABINS: Thank you all very much.

MR. GRIMALDI: Well, before you turn the tape off, I don't know whether I speak for everybody, but I think I do. I got a great deal out of these two days myself. Whatever you recover from our discussion, I hope it is going to be of value to you, but I think that we have had an opportunity to listen to our colleagues, some of whom I have never met before, and I look forward to meeting again. This has been refreshing. More than that, it has been stimulating, and I think that I am a better person for it, which is a part of, I suppose, the reason for having conferences. You are to be complimented therefore, for putting on a meeting like this. I hope you will be able to have more. I don't have time for meetings. I rarely go to them, as you know, but I certainly would come back to one of these.

MR. BOLGER: Thank you.

CONFEREES: MR. HENRY WAKELAND, JAMES FOLEY AND DR. ROBERT HESS

CONFERENCE STAFF: MR. ALAN WARSHAWER, MR. LAWSON MCKENZIE AND MR. WILLIAM BURNS

APPENDIX I

GUIDELINES FOR CONFERENCE/WORKSHOP
ON
INTERMODAL SAFETY RESEARCH NEEDS
SPONSORED BY
OFFICE OF SAFETY AFFAIRS
OFFICE OF UNIVERSITY RESEARCH
DEPARTMENT OF TRANSPORTATION

INTRODUCTION

The sixth in a series of conferences sponsored by the Office of University Research, Department of Transportation, will be held in Washington, D. C., on April 28-29, 1976. This conference will be directed to intermodal safety research needs of the Department of Transportation. The conference will bring together a multimodal group of Department of Transportation safety managers, university researchers and transportation industry representatives. The objectives of the conference are:

- To highlight safety problems and needed transportation safety research identified by Department of Transportation modal safety managers and to stimulate university or university/industry teams to respond with research proposals which emphasize multi-modal and applicability and a systems approach.

- To provide a forum for university and research groups to inform Department of Transportation safety managers of promising new directions in transportation safety research and new tools with which to address safety related problems.

On September 17, 1975, Secretary William T. Coleman, Department of Transportation, issued A Statement of National Transportation Policy. This document is a comprehensive statement of "the borad policy considerations that should underlie the Federal government's response to the Nation's transportation needs." In it, Secretary Coleman identified specific goals of the Department to meet requirements established by Congress. These goals establish excellent guidelines for this conference and for the university research efforts.

PLAN OF THE CONFERENCE

During the Conference, Department of Transportation safety managers will relate Secretary Coleman's statements to the specific safety problems of each mode. University and research groups will discuss new concepts, analytic tools, and available techniques applicable to the safety problems presented. The conference will discuss the safety requirements, identifying multimodal relationships and both specific and systems type problems. Conference objectives will have been achieved if the dialogue among the conferees enables modal safety managers to express requirements and to project research goals compatible with the maximum potential of analytic tools and techniques available, and if university research groups are able to focus their skills on mid-range problems being addressed by the Department of Transportation. The interactions are graphically displayed in Figure 1. (Page 3).

BACKGROUND

Transportation safety has been a matter of continuing public and Congressional concern. The Department of Transportation is responsible for carrying out the will of Congress to reduce accidents and casualties. In discharging these responsibilities (See Appendix 1: Transportation Safety Statutes Administered by the Department of Transportation), the Department engages in programs that range from broad institutional, legal, and economic policies, to highly specific improvements in materials and vehicles. As a result of its programs plus other factors known and unknown, the transportation safety programs appear to be working. The following table illustrates the trend.

TABLE 1: TREND IN FATALITY RATES, 1949-1973

Fatality rates per 100 million passenger miles[1]

Year	Air carriers	RR Pss[3]	Busses	Pass autos[2]	Gen. aviation[2]
49-57	1.26	.36	.21	2.87	47
59-61	.67	.10	.18	2.20	24
71-73	.13	.28	.21	1.80	20

1/ Except for general aviation which is fatal accidents per 100 million plane miles. (This translated into approximately 19 fatalities per 100 million passenger miles in 1971-1973, Source: FAA Statistical handbooks)

2 Automobile, taxis and general aviation include fatalities to all occupants, including the operators. Other modes do not include the operators.

3 Passenger fatalities as a rate of passenger miles is from Accident Facts, 1974, a publication of the National Safety Council. However, the primary safety problem of the railroads are non-passenger casualties, either employees or public/trespassers on the right of way. Of the 4,972 fatalities from 1967 to 1973, only 103 were passengers (FRA Bulletin No. 142). Any use of a rate can be misleading whether it be passenger miles, train miles, car miles, or ton miles. Other modes have different rates of passenger to employee casualties and other statistical measures apply.

Despite the favorable trend, the Department is not satisfied that it is doing all of the right things. If it had all the answers, accident rates would be approaching zero, and this conference would not have been called.

Transportation represents almost a fifth of our gross national expenditures. The impact of transportation on our national life is incalculable. Improved transportation safety, fewer lives lost and fewer injuries will not occur without effort. But, it is a fact of nature that you cannot change only one thing. This applies to an increase in safety. By making changes which can reduce the number of accidents or fatalities, we may increase the cost of transportation, destroy some transportation companies, change tax revenues of local and federal governments, modify historic land use patterns, reduce an areas's industrial base, change education and employment patterns, cause shifts in international trade and initiate other changes too numerous to mention. The influence of transportation on our economy and society makes vital a thorough understanding and careful review of any contemplated change.

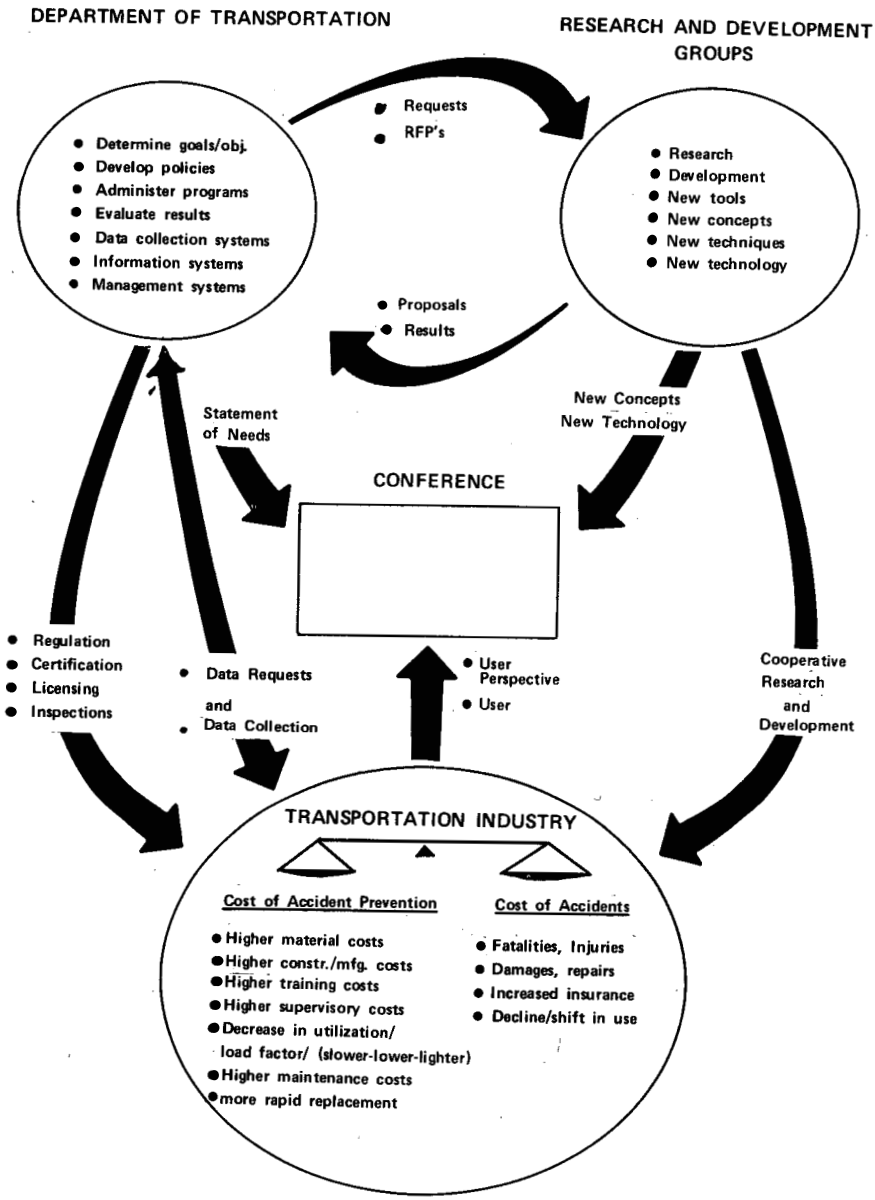

DEPARTMENT OF TRANSPORTATION
RESEARCH AND DEVELOPMENT GROUPS
Determine goals/obj.
Develop policies
Administer programs
Evaluate results
Data collection systems
Information systems
Management systems
Requests
RFP's
Research
Development
New tools
New concepts
New techniques
New technology
Proposals
Results
Statement of Needs
New Concepts New Technology
CONFERENCE
Regulation
Certification
Licensing
Inspections
Data Requests and Data Collection
User Perspective
User
Cooperative Research and Development
TRANSPORTATION INDUSTRY
Cost of Accident Prevention
Higher material costs
Higher constr./mfg. costs
Higher training costs
Higher supervisory costs
Decrease in utilization/ load factor/ (slower-lower-lighter)
Higher maintenance costs
more rapid replacement
Cost of Accidents
Fatalities, Injuries
Damages, repairs
Increased insurance
Decline/shift in use

Figure 1.

The growth of the transportation system has been due to many competing forces and each has an interest in any system change. The Policy Statement recognizes the "complex interdependent world in which all of our national concerns cannot be satisfied at once (34)" yet the document states:

> "--no Federal transportation responsibility (is) more important than the safety of the passenger, driver, transportation worker, pedestrian, and others exposed to the transportation system."

Recognition of the conflict of interests and the conflict among priorities underscores the importance of a Departmental management system which will enable the Department to:

> "--understand better the indirect economic and social consequences of our actions."
>
> "--recognize and evaluate the consequences of government action on the competitiveness of other modes--."
>
> "--strike a judicious balance between results achievable."
>
> "--improve the process by which the comparative effectiveness of federal expenditures is judged and seek a more rational allocation-----This requires an improved capability to plan comprehensively, to compare benefits and costs and to monitor the performance of the system, making adjustments in policy and programs as required to achieve the desired objectives---"

The Policy Statement places the problem of transportation safety in proper perspective. It is one of a set of priorities within the total transportation system, and all must be considered. Transportation safety must be viewed as a process, and an important requirement is to develop an information collection and management system which will establish objectives, weigh alternatives, and evaluate results.

WHAT PROBLEMS ARE WE TRYING TO SOLVE

The transportation safety problem generally is divided into three parts:

- Accident avoidance (or accident prevention)
- Accident survivability and damage limitation
- Emergency response and accident recovery

These problems have many potential solutions some of which may be unacceptable.

- A "safe" system might be too expensive to be economically feasible.
- To shift traffic to the "most safe mode" would have unknown effects on safety and on transportation economics.
- A safer, more crash-worthy car might require higher energy use.
- Improved emergency response would shift expenditures from the private to the public sector.
- Desirable safety features may be unacceptable to the public.

Based on its statutory authority, each modal administration initiates and manages programs directed toward improving safety in one or more of the basic safety categories (avoidance, survivability, recovery). These programs employ a variety of means: special funding to encourage safety measures, setting standards, inspection and enforcement, licensing, certification, and training. In support of its programs, the administrations engage in research and development for both hardware and software support.

In May 1975, The Fourth Workshop on National Transportation Problems addressed the role of government in transportation R&D. A copy of the report of the fourth workshop is included with the materials of this conference. This report describes in broad terms some problems of transportation R&D, including such considerations as:

- The division of responsibility for transportation R&D between federal, state and local governments
- The need for new institutional forms to speed introduction of technology
- What can be done to assure implementation of R&D findings?
- What is it worth to people to walk away from an accident without loss of life or limb?
- Can the socio-economic effects of federal initiatives be properly measured?
- How can the federal government trade off security, safety, time and convenience of transportation?
- Are there institutional barriers to technology implementation?
- What is the impact of citizen participation in decision making?
- Transportation research should pay closer attention to the value system of the potential users.
- Transportation goals are not clearly perceived.
- Lead time of technologic R&D is not significant compared to other lead times (economic, institutional, and environmental change).

Each of these points has special significance in the specific area of safety research. The Sixth Workshop can build on the previous one by examining safety aspects of such research requirements.

To find the right answers, we first must ask the right questions. We are not yet sure that we are doing so. When a problem of safety is observed it is attacked. But are we attacking at the correct point? Are we attempting to break down a wall that we could more easily step around? If in the early 1900's, transportation research had been directed toward increasing average transport speed, the solution would not have been an RFP for an aerodynamically perfect saddle. The solution required a new vehicle, the "horseless carriage." Too often specific safety problems are met by hardening, strengthening, or redesigning a sub-assembly. These approaches are meritorious and necessary, but they are not what we will be addressing in this conference. Review of the National Transportation Policy Statement shows that the Departmental priority research needs fall into three broad categories:*

*Extracts expressing specific needs for research are contained in Appendix 2

First: What are the institutional barriers to safety improvements, and how can they be overcome?

Second: By what planning process can safety goals best be established?

Third: What analytic tools, information systems and management systems are required by the Department of Transportation to set priorities, administer programs, and evaluate results?

This Conference will focus on research required to assist the Department of Transportation in these areas. Conferees will participate in one of three panels, each dealing with one of the above issues. A background and general introduction to each panel subject is contained in the following sections.

PANEL 1: INSTITUTIONAL PROBLEMS IN TRANSPORTATION SAFETY

OBJECTIVE: To clarify research needs in the area of institutional factors

PANEL DISCUSSION AREAS

Ia Federal-State-Local Relations

Who is best able to handle each aspect of the safety problem? Who has the responsibility under law? If differences exist, can they be reconciled?

What is the impact on State and local governments of differing enforcement strategies (regulation, incentive, persuasion, licensing, certification, fines, court action, etc.)

What is the impact of safety programs on State and local institutions (public funding, public services, education and training). How does this vary if the same goal is sought through programs for accident avoidance, accident survivability, or accident recovery?

Is there an optimum attainable responsibility among Federal, State and local authorities?

Ib Federal-Industry Relations

How much control is required to achieve a desired level of safety?

What has been the impact of safety standards and regulations on industry (safety, services, prices, energy use, economic viability, competition)?

Have safety programs caused distortion in competition or affected competitive entry in the transportation industry?

What is the impact of different enforcement strategies or intra- and inter-industry factors (regulation, incentives, persuasion, licensing, certification, fines, court action, etc.) on safety, by modes. (past and present)

Have federal funds for safety technology reduced or increased industry research and development? What is the proper mix?

Ic Federal-Public Relations

Has the representation of public interests been productive or counterproductive in setting safety standards?

How can the public's willingness to accept higher risk and lower cost (or conversely to pay a higher price for a lower risk) be determined?

What conclusions can be drawn from the public's apparent willingness to accept different risk rates in different transportation modes? Are institutional factors present (consumer groups, user groups, employee or other special interest groups)?

PANEL II: PLANNING AND GOAL SETTING FOR TRANSPORTATION SAFETY PROGRAMS: THE CONSEQUENCES OF PROCESS

OBJECTIVE: To relate the goal setting process with the probability of goal attainment.

PANEL DISCUSSION AREAS:

IIa Standards of Safety

Is it useful to differentiate goals in terms of reduction of accidents, reduction of injuries, reduction of fatailities, or reduction of probability of catastrophic accidents? Can meaningful goals be set in these areas?

How should standards reflect the differing risk rates of different groups: employees, users, public-at-large? Such groups have different safety expectations, receive different benefits and pay different costs, yet all interact in achieving consensus for goals.

IIb Willingness to Risk

What is the impact of willingness to risk on goal setting? On risk variation from one mode to another? On risk variation from one group to another?

How is willingness to risk related to willingness to pay for changes in the risk level? How is this related to acceptance of safety standards? How can willingness to risk be measured? Be modified?

IIIc Development of Standards

How does the development process relate to acceptance of the resulting standards?

What type of educational or public relation programs relating to risk perception and risk acceptance should precede or accompany the goal setting process?

What role should be placed by consumer groups, user groups, and other public groups in planning and goal setting?

What role should be played by State and local groups? What is the national impact of local variation in risk rate?

PANEL III: DEPARTMENTAL MANAGEMENT, INFORMATION, AND EVALUATION DECISION MAKING IN THE WORLD OF CHANGE

OBJECTIVE: To describe research needs for management of safety programs. This includes data collection requirements, information systems, evaluation systems and management systems which provide the capability to evaluate the consequences of safety program changes on the mode involved, other transportation modes, and on other national priorities.

PANEL DISCUSSION AREAS:

IIIa Information Systems

What are the requirements for data collection, data definition, storage, retrieval, dissemination, and use?

How should departmental systems interact with other systems for technology transfer?

IIb Analytic Tools and Techniques

What analytic tools and techniques are required for data analysis?

By what models should the social and economic consequences of safety programs be distributed by mode? by risk level? by class of user?

IIIc Evaluation System

Can evaluative criteria be established which measures all transportation modes on the same safety scale?

What evaluative criteria can be employed to measure program accomplishments? How should such data be collected and evaluated?

IIId Management Systems

What are requirements for integrating safety considerations into departmental management systems?

What is the modal transferability of safety strategies and techniques (incentives, licensing, fines, enforcement, etc.)?

APPENDIX 1

TRANSPORTATION SAFETY STATUTES
ADMINISTERED BY DEPARTMENT OF TRANSPORTATION

SUBJECT	STATUTE
Aviation Safety	Federal Aviation Act of 1958 (49 U. S. C. 1301)
Highway Safety	Title 23, United States Code, Chapter 4
Motor Vehicle Safety	National Traffic and Motor Vehicle Safety Act of 1966 (15 U. S. C. 1381)
Motor Carriers	Interstate Commerce Act, Part II (49 U. S. C. 431)
Hazardous Materials	Hazardous Materials Transportation Act 88 Stat. 2156 (PL 93-633)
Gas Pipelines	Natural Gas Pipeline Safety Act of 1968 (49 U. S. C. 1671)
Boating Safety	Federal Boat Safety Act of 1971 (46 U. S. C. 1451)
Port Safety	Ports and Waterways Safety Act of 1972 (33 U. S. C. 1221)
Navigation and Merchant Marine Safety	Various provisions of titles 14, 33, and 46, United States Code
Urban Mass Transit	Urban Mass Transit Act of 1964 (PL 89-562) Assistance Act of 1974 (PL 93-503)
Department of Transportation	Department of Transportation Act (PL 89-670)
Rail Safety	Railroad Safety Act of 1970 (45 U. S. C. 431)
	Rail Safety Improvement Act of 1974 (PL 93-633, 88 Stat, 2156

Note: See also 49 CFR, Parts 1-700; 14CF4100-190 (Aviation): 33 CF4100-199 (Maritime: 46 CFR 1-399 (Maritime)

APPENDIX 2

EXTRACT
STATEMENTS OF RESEARCH NEEDS
FROM
A STATEMENT OF NATIONAL TRANSPORTATION POLICY

The following are expressions of research needs drawn from A Statement of National Transportation Policy issued by Secretary Colemen September 17, 1975.

Page

1 "We must seek a more rational delineation of responsibility (for safety) among the levels of governments."

2 "Government should devote sufficient resources to the development and enforcement of reasonable standards of safety . . . ." (Question: What are reasonable standards? How are they determined? How can they be enforced?) ". . . .consistent with cost-benefit analysis where appropriate" (Question: When is it appropriate?)

2 "We need to use these tools (statutes, courts, administrative processes and analytic procedures) to make better decisions and ensure steady progress each year in reducing accidents."

3 "We must recognize and evaluate the consequences of government action on the competitiveness of other modes--- We must make a concerted effort to remedy the imbalance of past actions and assure fairness in future actions, or at least fully recognize and weight the adverse effects of present imbalances."

4 "The Federal government should define its role---in defining and working to advance national priorities through persuasion, incentive, regulation, and enforcement where the magnitude of the problems and their national importance require a federal response, e.g., safety."

5 "The Federal government should improve its performance measures -- in assessing the effectiveness of alternative federal programs and policy options and evaluating the health and progress of the transportation system."

5 "The automobile is a . . . . major contributor to fatalities, injuries, air pollution, high energy consumption and congestion. Both its technical performance and its more intelligent and socially responsible utilization are matters of urgent and continuing concern."

9 "Some common denominator is required against which public investments in alternative modes of transportation can be assessed."

10 (We will) monitor the effect of Federal actions in terms of:

"(a.) Is the public getting lower cost, safe, and efficient service?"

"(d.) Is the transportation sector, including the manufacture of equipment, growing in productivity, developing new technology, improving safety and performance?"

Page

13 "Standards adopted must strike a judicious balance between results achievable, costs, and secondary impacts."

15 (With respect to the entry of new firms) "We will encourage somewhat more liberal entry policies, recognizing the need to balance freedom of entry with the requirements of safety, financial fitness and reliable and accessible service to all customers."

22 "The dilemma for the decision maker lies in the paucity of information by which to gauge what improved levels of performance may be realized with different expenditure levels, or by which to conduct comparative analyses of what improvements may be expected with the same expenditure in different programs . . . . This requires new kinds of measurement including the development of measures of performance for making comparisons on an intermodal basis."

23 "We should improve the process by which the comparative effectiveness of federal expenditures is judged and seek a more rational allocation of federal resources . . . . This requires an improved capability to plan comprehensively, to compare benefits and costs and to monitor the performance of the systems, making adjustments in policy and programs as required to achieve the desired objectives."

24 "We should improve our capability to make cost-benefit comparisons of different Federal programs. For example, if we could measure the lifesaving impact of a given expenditure on Coast Guard search and rescue operations and on FAA air traffic control systems, we would be more confident about allocating limited resources between them."

29 " . . . . Research, development and demonstration on more efficient public transit, medical evacuation and accident prevention in rural areas."

33 "We need to improve the process by which we reach decisions to insure that the safety, environmental and economic consequences of alternative course of action are anticipated and understood."

33- "We must continue to improve the information base for decision making. Sound experimental and operational data should be obtained to the extent possible prior to implementing regulations. Cost benefit analysis is one useful mechanism for making comparative evaluations among alternatives. ---- We must make sure that all benefits and costs, including those that cannot be easily translated into monetary terms or ever quantified at all, are included in the analysis and weighed in the decision making process."

35 " . . . . the consumer should have some choice about how much he is willing to pay for additional safety, especially in private transportation systems. When hazards affect the safety of others, government as a protector of the public interest has a greater responsibility to step in and make the choice."

Appendix 2 (cont'd)

Page	
36	" . . . . critical review of the safety standards and regulations we have issued. The goal is to determine which of these provide net social benefits."
36	"We must define criteria (for safety) and establish a process that will help us arrive at reasonable actions in the public interest and insure incremental improvements in safety each year commensurate with advancing technology, improved facilities, and consideration of other federal priorities . . . ."
36	"We also are attempting to develop a model automobile the occupants of which would survive a 50 mile per hour head on crash."
40	"Education programs and curriculum guides for teachers from kindergarten through the adult level or enable students to become effective transportation consumers and ultimately, more knowledgeable participants in community transportation planning."
41	" . . . . we seek solutions through opening up the process to all consumers. For making consumerism work requires the commitment of those who use, benefit from, or are deprived of transportation services."

APPENDIX II

CONFERENCE ON
INTERMODAL SAFETY RESEARCH NEEDS

APRIL 28-29, 1976

ATTENDANCE LISTS

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APPENDIX III

LISTING OF IDENTIFIED RESEARCH REQUIREMENTS FROM THE INTERMODAL SAFETY RESEARCH NEEDS CONFERENCE

HELD APRIL 28-29, 1976, WASHINGTON, D.C.

Partial Listing of needs from conference transcript organized by:

I. General

1. Development of optimum organization at state and local level to respond to federal programs.

2. Impact of federal revenue sharing vs program grants to states for safety programs.

3. Value system analysis involving public perceptions (including segmentation) example: "independence" vs safety rule.

4. How can we "sell" the public on the safety measures, or a safety problem in general? What art motivators?

5. How can safety warnings (vehicle) be made credible to the public when the accident rate is one to 30 million miles of travel?

II. Program/Evaluation

1. How does regulation affect safety?

2. To what extent does the market process under-produce or over-produce safety?

3. Are Safety problems best addressed by rules and regulation or through dissemination of information, insurance, and other means?

4. What are factors involved, and how to evaluate balance between:

   a. safety and transportation system efficiency
   b. safety and other socially desirable goals
   c. safety and economic viability of competing modes
   d. safety and various safety program options

5. How can we predict the consequences of various safety programs?

6. What information is required to make safety program decisions?

7. Methodology for balancing long range programs against short range requirements involving diversion of resources.

8. Determination of adequacy of data for problem solving

9. Risk analysis methodology, particularly balancing U.S. energy requirements against probability of accident.

10. Reporting system requirements for data collection, evaluation and program management.

11. How much research is required before decision is made in the face of uncertainty.

12. Is the Highway data base adequate for decisions of the agency?

13. What is the effect of lack of uniformity in state and local police reports; what gains if uniformity achieved; what costs?

14. Cost benefit analysis involving safety costs vs lives saved, pollution, energy use, etc.

15. Is the statistical data base adequate for decision making?

16. Cause and effect relationship of equipment changes; risk analysis.

17. Methodology for establishing safety program priorities.

18. Data base requirements for equipment maintainability and reliability prior to equipment standardization program.

19. Methodology for local transit planning.

20. Prioritization methodology for break away signs and impact attenuators on 3.8 million miles of low risk probability roads.

21. Effectiveness evaluation of safety programs.

22. What data should be collected from police accident reports; balance benefits against cost of attaining data and probability of consistent collection?

23. Methodology for aggregation of data on low volume roads for determining countermeasures to be employed.

24. Methodology for hazard rating formula for high hazard locations.

25. Development of surrogates for fatalities in hazard ratings.

26. Data requirements for effective rule making (Data to be accurate and convincing).

27. How to measure effectiveness of fleet safety programs.

28. Need for national monitoring system or "listening device" to perceive changes and safety impacts (e.g., people afraid of small cars due to lack of safety, yet such vehicles pushed by EPA).

29. How to prove or disprove effectiveness of driver training.

30. How to develop a rigorous experimental design for situations involving very small effects in a "noisy" environment.

31. What methodology can be used to determine the level of safety acceptable to the public?

32. Social and economic models for evaluation of safety programs.

33. Evaluation of enforcement rules and strategies vis-a-vis highway system design. What is best enforcement strategy for safety standard (Example problems: motorcycle helmet laws, seat belt interlock system, search and rescue).

34. Impact on safety and interstate commerce if states permitted to establish differing rules on safety which precluded free movement of vehicles across state borders.

35. Cost of safety programs vs benefits: case studies, to include effect on competition.

36. Should we legislate hazardous materials transportation off one or more modes of transport as unsafe? Economic impact?

37. Does the procedure which provides for representation by organized groups skew the safety program solution unfavorably?

38. How should DOT publish or publicize its proposed rule making for maximum response and maximum safety input.

39. Methodology for determining values and acceptability of safety program.

40. What is best measure of exposure to evaluate modal accidents and to make intermodal comparisons for resource allocation?

41. How can the accident rate for vehicles going into production be predicted in order to develop risk levels, or to make such consumer information available? Normally risk levels are based on accident experience.

42. What are the parameters and limitations of data requirements for safety program decisions?

43. What are the data requirements, (definitions, by user, by mode, by decision type)?

44. Should data collection systems be based on accidents, or on incidents involving both accident and non-accident failures? Are there other surrogates for accidents?

45. Need for national collection system for movement of hazardous materials; by type material, by quantity, by packaging, by mode.

III. Human Factors (communications/motivation)

1. Human factors research: 85% of sea accidents involve human failures, Research in -man-machine interface, selection criteria, training, SOP's, motivation, full range of "people problems".

2. Safety requirements for large LPG carriers and petroleum carriers, particularly personnel qualification, selection and training criteria.

3. Material classification for hazardous materials transportation.

4. Handling of hazardous materials (qualification, training, inspection, facilities, packaging) detection, evaluation of risk.

5. What factors are involved in driver motivation and behavior modification.

6. Why do drivers behave the way they do?

7. Human factors, man-machine interface problems.

8. Human factors, use and effect of simulators in training.

9. Human factors: psychologic effect of various design features.

10. Devices to keep drivers awake and attentive.

11. Effect of age; we have minimum age--should we set maximum age? how?

12. How will social changes of next 20 years affect the accident environment?

13. What is the most effective occupant restraint system, acceptable to occupants?

14. What will be the impact on vehicle and highway design of solving the occupant restraint system problem and having a vehicle environment which presupposes a fully restrained occupant?

15. Methodology for information exchange at state and local level.

16. Mechanism to define clearly safety responsibilities among the various jurisdictions; federal, state, local. Organizational, communication problems.

17. Safety coordination for Federal-State safety.

18. Identification of aspects of Air Controllers performance which are most likely to result in critical control errors.

19. Comprehensive study of human failures in ATC system.

20. Applicability and impact of screening criteria/tests for air controllers.

21. Can (and how) we change the attitude of the public by changing the rule making process to more involve the public?

22. Attitudinal research involving safety, behavior, risk taking.

23. Research results must be communicated to be useful. This communications must be in acceptable language for the user. Can we establish requirements?

24. Risk-taking characteristics of various population groups.

25. Driver Education Standard and Curriculum to be revised to include emergency action requirements.

26. Pedestrian traffic motivational research.

27. Development of safety requirements and safety changes involving the elderly and handicapped groups. (Wheelchair tie-downs in busses, seating arrangements, location of fare boxes).

28. Study of risk taking behavior in different life stages (ages).

29. Study of risk taking behavior as result of employer expectations of contractural obligations. (Drivers and schedules, Operators and norms, etc.).

30. How are information requirements of users defined; how can we get information to users, decision makers, RFP's, proposal writers, etc?

31. Human factors, effect of communication overload on driver; how to avoid this overload through sign type, location and through modification of requirement for transmitting information to driver.

IV. Machine/Materials/Equipment

1. Safety requirements for:
   - Offshore pipelines
   - LPG technology
   - Hydrogen embrittlement
   - Stress corrosion cracking
   - Welding technology
   - Plastic pipe technology
   - Oderants
   - Pipe coating and cathodic protection
   - Arctic environment

2. Wheel-rail technology.

3. High speed rail flaw detection technology.

4. Prevention of chain reaction propagation in hazardous materials transportation.

5. Thermal shielding and coating technology.

6. Cargo shifting model.

V. Environment

1. Safety requirement in cold temperatures.

2. What is appropriate fail-safe methodology in transit operations?

3. Creating a "forgiving highway" through highway design.

4. Effect of weather and weather information on accidents.

5. Perception and optical illusion creates accidents on highways. What training can overcome or environmental modifications prevent such illusions.

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