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MPLICATIONS OF FUEL-EFFICIENT VEHICLES ON RIDE QUALITY AND PASSENGER ACCEPTANCE:

WORKSHOP PROCEEDINGS

WOODS HOLE, MASSACHUSETTS, SEPTEMBER 6-8, 1978

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16. Abstract

This report summarizes the proceedings of the 1978 workshops on passenger ride acceptance/fuel economy tradeoffs jointly funded by the U.S. Department of Transportation and the National Aeronautics and Space Administration. Four workshops were conducted under the auspices of the Transportation Research Board's Committee A3C11 on Ride Quality and Passenger Acceptance at the National Academy of Sciences Summer Study Center, Woods Hole, Massachusetts, from September 6-8, 1978. Topics of discussion included ride quality and passenger acceptance problems associated with enhanced fuel efficiency of automobiles (Group A) and aircraft (Group B); shifts in intermediate range (100-500 miles) travel from automobiles to public transit (Group C); and implications of increased size disparity for ground transport freight and passenger vehicles using shared guideways (Group D). In each group, major problem areas were identified and strategies for conducting pertinent research were outlined. A glossary of technical terms and a list of workshop participants are also included in the report.

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Preface

As editors, we would like to exercise our prerogative to thank all our friends and colleagues whose efforts made this workshop successful and this report possible. We refer to the group leaders and group recorders whose names appear elsewhere in this report, to Don Sussman of DOT/TSC who so ably directed the conceptual organization of the workshop, to Ann Symmers and Ralph Stone of the University of Virginia who assisted in making the general arrangements for the meeting and in its daily operation, and to Connie Robinson and all the members of the staff of the National Academy of Science Summer Study Center at Woods Hole, whose untiring efforts made our stay so pleasant and enjoyable.

A special expression of gratitude on behalf of all the attendees is due to Jack Fearnsides, Deputy Undersecretary of Transportation who, as he has at our past workshops, made a special effort to share an evening with us. It was most stimulating and profitable for all.

The workshop was funded in part by the U.S. Department of Transportation, through the Transportation Advanced Research Project of the Office of Systems Engineering, Research and Special Programs Administration, and by the Noise Effects Branch of the Acoustics and Noise Reduction Division of the NASA/Langley Research Center. Financial support was also indirectly obtained from the many organizations who provided the time and supported the expenses of their staff members who were in attendance. On behalf of the members of the TRB Committee A3C11, we wish to acknowledge our indebtedness and extend our thanks to all these organizations. Without their support, there would have been no workshop.

Finally, it should be emphasized that the reports of the specific groups are primarily the work of the recorders

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1. INTRODUCTION

1.1 BACKGROUND AND OBJECTIVES

The transportation segment of our economy is a major user of energy and, in particular, petroleum fuels. Within this segment, there is considerable heterogeneity with regard to fuel efficiency both between transportation modes and between particular systems within modes. Choices of mode or system are not usually based on fuel considerations alone; however, the rising costs of energy and the predicted shortfall of petroleum fuels can be expected to increase profoundly the importance of fuel efficiency in the users' selection processes and directly influence the design of future systems.

Public acceptance of any mode is based on an interaction of factors beyond fuel efficiency; therefore, it is vital to understand the acceptability implications of planned or proposed changes in the features, design, and operations of transportation systems which are associated with increased efficiency.

To achieve optimum fuel efficiency while maintaining or improving on the existing level of service in transportation, two major areas must be addressed:

a) development of the most energy-efficient vehicles and operating systems possible within each mode and,

b) development of an improved understanding of the factors which will influence users to select transportation consistent with energy conservation for each trip or shipment.

Much work has already been done on the first issue. However, it has tended to focus on the technological aspects of improved energy efficiency and their effects on costs. Progress in the the second area is less obvious, although most certainly of equal, if not greater, importance.

Traditionally, mobility has been considered as a basic freedom of the individual, and our entire economic structure is based upon its availability. Thus, it would seem prudent

(3) to estimate the impact on user acceptance which will result from changes in these parameters;

(4) to define specific problem areas or policy issues which require further study, in order to improve the ability to predict the effects of technological and social developments on the use and manufacture of transportation systems;

(5) to suggest possible approaches to the solution or investigation of these problem areas.

1.2 ORGANIZATION OF THE WORKSHOP

Rather than attempt to address the entire subject area, the Committee decided to form four working groups, each charged with a particular aspect of the overall transportation energy problem which was felt to be especially important. Group leaders were selected early in the spring and they, together with members of Committee A3C11, were responsible for selecting the individuals to be invited to participate. Although the basic format for the workshop called for the groups to work independently, ample opportunity was provided for interaction between the groups, both by regularly scheduled plenary sessions, as well as by informal consultation between groups.

As was the case with the most recent workshop held by the Committee,* the University of Virginia was asked to serve as coordinator for the meeting. In addition to arranging for the meeting logistics, the University's School of Engineering and Applied Science agreed to provide a participant for each group who would serve as a recorder for

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*Kuhlthau, A. Robert (ed.), "Proceedings and Findings of the 1976 Workshop on Ride Quality," Lake Morey Inn, Fairlee, Vt., October 13-15, 1976. Report DOT-TST-77-38, NASA-CP-2006.

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It became apparent quite early in the discussions that factors such as consumer attitudes about the existence of an energy shortage and the hierarchy of importance of vehicle attributes in the purchase decision cannot be overlooked. Such factors contribute new inputs to vehicle design criteria and complicate the problems facing industry.

2.1.3 Definition of the Group's Task

As a result of the above considerations, it was decided to split into two subgroups. The first subgroup concerned itself with the relationship between enhanced fuel economy and the technical problems facing the vehicle designer. The second subgroup addressed the subject of customer attitudes, not only toward vehicle ride quality and performance, but also on the overall perception of the general issues related to energy conservation.

In both cases the subgroups attempted to:

- summarize the present status of increased automobile fuel efficiency efforts and indicate implications or trends for the future
- identify specific problem areas
- suggest future research needs.

The following report made by Group A is thus composed of a summary of the deliberations of the two subgroups.

quality. The group discussed and summarized the major technical problems involved as follows:

1. Material substitution often may lead to manufacturing cost savings because one part may replace a previous assembly. Conversely, from the standpoint of the customer, this may mean more costly accident damage repair.
2. Material substitution may introduce new corrosion problems from electro-chemical interaction of dissimilar metals.
3. Weight and size reduction may lead to new stability problems as vehicle mass centers change more drastically with engine and passenger placement.
4. Weight and size reductions influence vehicle ride, handling, and noise characteristics. This results in a greater need for integrated design methods using computer simulations to analyze and meet the constraints on design changes.
5. As unloaded (curb) weight drops, variable payload weight becomes a larger fraction of total weight. This increases problems of suspension travel, stiffness, and vehicle dynamics.
6. Present day vehicle designs provide relatively rigid body and frame structures having natural vibration frequencies that are much higher than those of the suspension and tire wheel-axle assemblies (unsprung masses), thereby removing the chance for dynamic interaction in the form of resonant vibration modes. If, in the course of weight reduction, the stiffness of body frame panels is substantially reduced, the sheet metal parts

penalties and design problems which must be addressed in the use of these tires.

12. Downsizing of vehicles is not accompanied by reduced engine accessory loads in all areas. Electrical requirements, for example, remain essentially unchanged, as do passenger heating and air conditioning loads. Therefore, fuel economy gains will not be directly proportional to downsizing.

2.2.3 Status of Current Technology

It was generally conceded that most of the basic engineering technology for solving problems is available. Current needs involve the speed with which they can be brought to bear on the problems and a more concise definition of goals and criteria. For example, as references (3, 5-14) indicate, sophisticated computer models of vehicle dynamics are available but are not used or even available throughout the industry. Similarly, while composite materials are known to be of considerable value, the task of defining their properties through test and analysis is beyond the capabilities of industry alone in view of the urgency of incorporating them rapidly into vehicle designs. The short time frame also introduces the need for more generalized ride, safety, and performance standards which are flexible enough to encompass new design concepts without inhibiting innovation.

2.2.4 Proposed Research

The group identified nine areas where research is needed. These are summarized in Table 2-1* and discussed briefly below.

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*In order to preserve continuity, Table 2-1 appears on Page 17

4. Effects of Downsizing and Associated Changes in Suspension Geometry on Ride, Handling, and Safety

This work might involve the use of existing computer models to perform generalized studies of the results of downsizing to give guidance for future vehicle designs. As was mentioned before, smaller vehicles require more careful attention to the interrelationships between suspension, aerodynamics and other factors (2). This increases the importance of integrated design techniques. A generalized vehicle simulator could be of great assistance in this area.

5. Technology Transfer of Advanced Vehicle Dynamics Analysis Techniques

The group recognized that technology transfer schemes are not always successful, but felt that the available knowledge of ride quality criteria, new materials, structural dynamics and advanced computer modeling needs to be better distributed throughout the industry. In terms of potential savings in time and effort, this project has a high pay-off if successful. While it was not clear exactly how much technology might be handled most effectively, a low level, long-term program implemented through professional societies was proposed.

6. Effect of Government Standards on Efficiency of Vehicle Designs

Several members of the group pointed out situations in which government standards conflict with the need for more fuel-efficient vehicles. It was indicated that current or proposed standards may be inappropriate for new design concepts or materials and may limit innovation. The potential

TABLE 2-1. SUMMARY OF NEEDED RESEARCH ON VEHICLE ENGINEERING

RESEARCH ITEM	PAYOFF	RISK*	FUNDING**	PRIORITY
Properties of Lightweight materials (Strength, vibrations, manufacturability)	Very High . Large potential energy savings . Will reduce time to implement design changes	Very Low	Moderate to high (Long term)	Very High
Consumer Acceptance of New Materials	High . Helps understand and counteract rejection of beneficial improvements	Moderate	Low	High
Aerodynamic Properties of Low Weight and Low Drag Vehicles	High . Provide needed drag data . Avoid detrimental impacts on safety and handling	Low	High (Long term)	High
Effects of Downsizing and Changes in Geometry on Ride, Handling, and Safety	Moderate . Establish downsizing trends and directions . Provide guidelines for future vehicle designs	Moderate	Moderate	Moderate
Technology Transfer of Advanced Vehicle Dynamics Analysis Techniques	High . Better distribution of existing knowledge . Speed up implementation	High	Low	Moderate
Effect of Government Standards on Efficiency of of Vehicle Designs	High . Poorly defined standards may limit innovation . Standards may not match characteristics of new designs	Low	High	High
Ride Quality, Noise, and Handling Criteria for Drivers	Moderate . Leads to design improvements . Clarify differences between driver and passenger	Moderate	High (Long term)	Moderate
Suspension System Optimization	High . Minimize cost, weight . Look at active control systems	Moderate	Moderate	Moderate
Determination of Vehicle Life Cost	High . Determine relative influence of vehicle attributes	Low	Low	High

* Risk is defined as the probability that the project will not achieve its desired goals.

** Funding levels are defined as:

Low = Under $100,000/year
Moderate = $100,000 - $300,000/year
High = Over $300,000/year

economy standards (vehicle and engine size reduction) are in direct opposition to the customer's perception of desirable vehicle characteristics. It is important to differentiate here between customer perceptions and actual fact, since size reduction does not necessarily imply degradation in comfort and safety. The vehicle designer is thus faced with the task of satisfying customer and regulatory demand simultaenously. To do so he must have a better understanding of how the customer will respond to various design changes from other than a rational viewpoint.

2.3.3 Impact on Required Research

The constellation of consumer beliefs relative to the energy shortage is not consistent with a massive move toward the purchase of fuel efficient vehicles. However, it was noted that the 1977 General Motors downsizing of its standard size cars is generally considered to be successful. Consumers bought the cars. In addition, it appears that the desire to obtain better fuel economy is a major motivating factor among those who purchase these downsized cars. Further research was called for to clarify the apparent inconsistency between consumer disbelief in the energy shortage and their purchase of fuel-efficient vehicles.

2.3.4 Approach to Research

It was emphasized that by and large, the research required is in the nature of marketing, and it is vital that this be very carefully structured. The marketing concept was summarized as having four principal components: (1) monitoring of consumers; (2) communicating to consumers; (3) monitoring the response of consumers to the communications and the products; (4) modifying products and communications to serve the needs of consumers better. The need to divide the consumers, such as future auto buyers, into market to fuel-efficient vehicles. The group felt that this approach was complementary to the demographic analysis suggested in the previous paragraph. It was also felt that the pay-off from this approach would be high and the risk relatively low. Consumer survey techniques would result in the acquisition of both attitudinal and demographic data as well as auto ownership and usage patterns. By collecting data from individuals, it will be possible to perform analyses at a finer grain of detail than is possible in the county level of analysis suggested above. Through such methods as multidimensional scaling, causal analysis, and conjoint measurement, it will be possible to develop models which describe the process by which consumers come to own vehicles of different sizes. This process is important because it will help to design improved marketing strategies for the sale of fuel-efficient vehicles, and it will aid in the understanding of the impacts of Federal regulations on the automobile industry.

3. Travel Diaries

Travel diaries by vehicles at the household level were suggested as a third research approach. This research strategy was evaluated as having a high potential pay-off, but it was felt that there was a moderate risk of obtaining that pay-off. The panel members expressed concern over the validity of diary data. People who agree to fill out questionnaires over time are likely to be different from the general population who will avoid the onerous task. On the other hand, it was felt that the methodology could generate some highly useful information such as number of miles traveled by vehicle, fuel consumption by vehicle, occupancy by risk of failure. In gaming simulation, a set of procedural rules are developed which provide the subject/participant with feedback on the outcomes of his or her responses. The participant selects one type of vehicle from a choice set, and then uses it in various simulated situations. Vehicle use is constrained by rules dictated by the vehicle's hypothetical performance, capital maintenance costs, and other capacities. As the game progresses, the implications of the vehicle choice "feed back" and affect the player/participant's subsequent decision processes.

Gaming simulations are different from field simulations in that they require no hardware, and can be used to evaluate radical changes in the automobile and/or the overall transportation system in which the automobile is used. Proper design of the games can provide valuable insight into potential public response to automobile design and transportation systems use as a whole. Design of an appropriately sophisticated game requires extensive efforts by highly skilled researchers, but, once designed, the game can be readily and economically modified to examine numerous possibilities at low cost.

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3. GROUP B

RIDE QUALITY AND PASSENGER ACCEPTANCE PROBLEMS ASSOCIATED WITH AIRCRAFT FUEL EFFICIENCY

3.1 INTRODUCTION

As its first task, the group undertook the definition of the specific areas with which it should be concerned in discharging its responsibilities. These are areas in which technological advances leading to increased fuel economy are taking place or will occur in the future, and the means by which the impact of these technological advances on ride quality and acceptance will be evaluated.

In response to the former, the following general areas with specific developments within each were identified for further study:

1. Aerodynamics
   - . New airfoils
   - . Laminar boundary layer control
   - . Variable camber*
   - . High-lift devices
   - . Computational techniques
2. Propulsion
   - . Jet
   - . Propeller
   - . Types of fuel
   - . Blowing techniques* (V/STOL)
   - . Drive train (helicopter)
3. Structures
   - . Structural design
   - . New materials
     - composites
     - aluminum technology

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*See Glossary at the end of this section.

- Performance of service
    - dependability
    - convenience of use
    - scheduling
- Seating
    - accommodations
    - capacity
- Amenities.

It was also noted that the elements of human factors involved in this process of acceptance evaluation are in themselves a discipline in which technological advances are occurring and likely to continue to occur. Thus it too must receive consideration in a manner similar to the five areas identified above.

Having defined the scope of the effort, a method of approach was next outlined as follows to conform with the general objectives of the workshop:

(1) Examine the state-of-the-art in each technology area;
(2) Define in more detail the fuel efficiency implications of the various specific developments in each area;
(3) Estimate the probable impact that each will have on ride quality and acceptance;
(4) Predict the time frame for possible implementation of these developments;
(5) Identify future research needs.

The remainder of the report will summarize the application of the first four steps of this approach to each area in turn, and will conclude with sections which will illustrate the implications of fuel efficiency to the future development of aircraft types and summarize recommendations for the overall research needs which now exist.

Let us now examine several specific designs which are either well tested and ready for application or in the research and development state.

3.2.1 Supercritical Wing

This device, which is currently in use on some types of aircraft, provides for a higher aspect ratio*, thicker wing which offers a marginal amount of fuel savings. The feeling is that future designs may have aspect ratios as high as 10 or 12 vs. the normal 7-8. A higher lift coefficient is obtained at maximum L/D, and hence an increased sensitivity to gusts. Some type of gust alleviation (sweep or active controls) will probably be required to maintain current standards of ride quality.

3.2.2 Variable Camber Wing

This is a new development under study at NASA/Langley. The concept is to be able to continually vary both the leading and trailing wing edges during flight. In this manner the wing may be optimized at every point in flight for the match between drag reduction and lift distribution on the wing. Resultant fuel savings should run about 2 or 3 percent. There will probably be little effect on ride quality, but the visual changes to the wing in flight may generate some image problems among certain types of passengers.

3.2.3 Other Drag Reduction Techniques

A major area for drag reduction is interference drag*, and improvements in fuel economy at a given speed may range from 2 or 3 percent in transports to somewhat higher values in general aviation aircraft. From the acceptance point of

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*See Glossary at the end of this section.

There are ways to compensate but, in general, they may lead to increased cost, complexity and even some reduction in the apparent fuel savings.

The implications on noise are not at all clear. The suction devices will generate noise, but it is quite likely that the net results will be less than a direct additive effect. The noise characteristics will probably change but the details of these changes and their effects are not yet well understood. The general feeling seems to be that there will not be any major effects on either interior or community noise.

3.2.5 High Lift Devices

High lift devices serve to increase the lift to drag (L/D) ratio, thereby potentially improving fuel economy. Generally, most conventional devices have been utilized as alternatives to simplification of wing designs, resulting in reduced maintenance costs. High lift devices have not traditionally been used to improve fuel economy. In fact, powered (as opposed to conventional) devices are poor in fuel efficiency and appear to have no real commercial potential.

3.2.6 Computational Techniques

Improved computational techniques for aerodynamic design will greatly enhance the ability to conduct more comprehensive analyses of system and component integration. A synergistic effect should result leading toward the inclusion of more new techniques into the early stages of configuration design. Thus all technologies can be combined toward common objectives of fuel efficiency and better understanding of human factor inputs such as noise and vibration.

TABLE 3-1. THE EFFECTS OF ADVANCES IN AERODYNAMICS TECHNOLOGY

	TIME FRAME	RQ	PA	CA	FS
AIRFOILS	MED	U	U	-	M
LAMINAR BOUNDARY LAYER CONTROL	FAR	N	N	-	P
HIGH-LIFT DEVICES	NEAR	P	P	-	-
VARIABLE CAMBER	FAR	-	-	-	M
COMPUTATIONAL TECHNIQUES	NEAR	P	P	P	M
DRAG REDUCTION TECHNIQUES	MED	P	P	-	M

P - POSITIVE
N - NEGATIVE
- - NIL
M - MARGINAL
U - UNCERTAIN

RQ - RIDE QUALITY
PA - PASSENGER ACCEPTANCE
CA - COMMUNITY ACCEPTANCE
FS - FUEL SAVINGS

have included the problem of cabin environment in a list of four major technology requirements before they will seriously consider the turboprop engines for advanced high speed commercial aircraft. Thus, the largest potential for fuel efficiency in commercial aircraft may hinge on the ability to provide a cabin environment that is as good as the present turbofan aircraft.

The basic problem stems from the fact that the propeller tip speeds will probably be supersonic in order to achieve the cruise speeds desired. Thus, there will be tip shocks against the fuselage and pure tone noises and "beating" are anticipated in the cabin. At the present time we have very little information for the design of fuselages or cabins to attenuate pure tone noise, nor do we understand the passenger reactions to pure noise in the range of 100-200 Hz. The answers to these questions will certainly govern the acoustic weight penalty that must be imposed on the aircraft, and may even determine the ultimate viability of of the aircraft for passenger service.

In the terminal areas, the noise of turboprop aircraft on the ground should cause no problem. Current technology is already much quieter in this regard than the DC-10. However, there may be some problems from the propagation of weak shocks from the blade tips on take-off and landing.

It is anticipated that the operating characteristics of the turboprop engines will be similar to the turbofans and so flight profiles, sensitivity to gusts, etc., should be about the same for equivalent missions.

they impact on user acceptance. It is extremely expensive to produce and handle. Also, since it must be carried in the aircraft as a liquid, it causes high volume requirements for storage. This also calls for a wider fuselage which could cause poorer ride quality, particularly in the lateral mode.

3.3.6 Summary

The effects of advances in propulsion technology are summarized in Table 3-2.

3.4 STRUCTURES

3.4.1 Materials

New materials for use in the structural design of aircraft generally fall into two main classes, composites and advanced metals.

a. Composites
  - Provide weight reductions of 25-35 percent per part
  - Reduce mass required for balancing on balanced surfaces
  - Improve response of control surfaces - due to reduced mass
  - Stiffness will have to be tailored (perhaps with some weight and size penalties) to meet the requirements of aeroelasticity and aerodynamic deflections.

b. New metals
  - Advance aluminum alloys show promise of a 10-12 percent weight reduction

- Super plastic-formed-diffusion-bonded titanium is also a possibility
- Both of the above could lead to higher allowable operating stresses.

3.4.2 Applications

The introduction of new materials into production will depend upon the component being replaced. Some examples are:

- Aerodynamic fairings* (now being done)
- Primary structure (approximately 1990 time frame) Emphasis will be on tailored stiffness rings to bolster flimsy aircraft members and on use in high aspect-ratio wings. Also fuselage applications
- Engine cowls, nacelles*, etc.

3.4.3 Fuel Saving

The potential saving in fuel due to new materials is, of course, directly related to weight reduction. However, the problem here is that many manufacturers and customers are currently interested in seeing this weight reduction translated into improved performance characteristics such as increased payload, range, etc., resulting in little change in the gross weight of the aircraft.

3.4.4 Acceptance

There are several groups influenced, each with their own concerns.

a. Builder

- There is a general lack of experience with the new materials; this leads to development costs to acquire a data base, develop design methods, determine certification procedures, etc. - e.g., fatigue.

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*See Glossary at the end of this section.

three major classes.

a. Retro-fit aircraft

Very limited. On current aircraft, it is usually too costly to change materials in an existing design.

b. Derivative aircraft

Some potential exists for special applications.

- Lockheed is changing from a mix of aluminum and fiberglass to Kevlar/epoxy on leading edge and trailing edge panels, and some fairings on long range L-1011-500 aircraft.
- Douglas is considering applications in control surfaces for derivative DC-10.

c. New aircraft

Potential is good. For example, proposals for the Boeing 767 call for about 4,200 lbs, of composites.

3.4.6 Summary

A summary of the effects in structures is shown in Table 3-3.

3.5 FLIGHT CONTROLS

In the context of today's proven applications and future potential, flight controls offer both a possibility for increased fuel efficiency and a definite improvement in the motion components of ride quality. These benefits can accrue either directly, through such means as motion and vibration alleviation to improve ride quality, or through energy management systems. Flight controls can also help in an indirect sense by compensating for ride quality deficiencies generated by other fuel-saving devices or techniques. Common, or routine, application of flight controls will also encourage other technological developments such as boundary layer control, structural weight reduction through load alleviation, etc. Load alleviation systems can be used to improve fatigue life.

Flight controls fall basically in three categories: reversible, separate surface, and irreversible. An indication of what might be expected in each is outlined below.

3.5.1 Reversible Controls

Examples: Cessna C 172
Learjet 35/36
Ride quality: Auto pilot loops with inner damping loops can provide some ride improvement.
Fuel economy: Nil.
Problem: Feedback of surface motions to pilot and/or to pedals and wheel.

3.5.2 Reversible Controls with Parallel Separate Surface Automatic Controls

Examples: U. Kansas/NASA/Beech M99
Learavia "Futura"
Ride quality: Significant improvement attainable
Fuel economy: Significant load alleviation is possible and reduction in overall empty weight of about 5 percent is expected. These could be reflected in either increase in operating performance or in fuel economy. Also, there should be a reduction in induced drag.

3.5.3 Irreversible Controls

Examples: Boeing 747

Ride quality: No effect

Fuel economy: Will reduce system weight by eliminating direct mechanical links to control surfaces.

Problem: Acceptance by civilian users and authorities must be secured.

d. Fly-by-light

Example: Under development, but has been flight-tested on the YC-14.

Ride quality: No effect

Fuel economy: Will reduce system weight even more than fly-by-wire, and is more reliable.

3.5.4 Summary

The results are summarized in Table 3-4. Essentially, the use of flight controls requires little energy for their own operation but can cause significant savings in aircraft weight, which could be translated into fuel economy. They also offer significant economies in the areas of maintenance and aircraft life through applications in load alleviation and flutter suppression. Flight controls can be used to automatically optimize operational parameters and thus provide direct energy management which should have a significant effect on fuel economy. Reductions in vibrations and motions could be improved by a factor of 10, leading to much better ride quality.

Most techniques are available today to design the flight control systems, but increased application is dependent on the availability of advanced computational techniques involving multi-technology or inter-technology applications to overall aircraft design. Most of the major advances will take 10-15 years to implement in fleet aircraft.

3.6 OPERATIONS

This is a highly complex area involving all the activities of the aircraft from the time of engine start at the origin gate to engine cut-off at the destination gate. There is no doubt that fuel economies can be realized by minimizing delays encountered at each activity and also by providing the best possible flight trajectories and profiles from take-off to landing. However, at this time, there is insufficient data generally available to make any quantitative predictions of the potential fuel savings.

Ride quality and acceptance enter the picture both from the viewpoints of the passenger and the community. Generally speaking, delays frustrate the passenger and represent serious impacts on the convenience and dependability of the service, in addition to the direct time element which is of utmost importance. The passenger comfort aspect of ride quality suffers when aircraft are required to operate at low altitudes or in adverse weather situations for extended periods of time. Low altitude as well as ground activities have an adverse effect on the community through both noise and pollution.

From this brief introduction it is clear that there are considerable contributions which can be made in both fuel economy and passenger/community acceptance through improvements in operating procedures. There is much work being done in certain sectors, but the important point is that the whole area of operations is subject to a rather severe set of constraints. Some are natural, such as weather, terrain, winds, shear, human fatigue, etc.; some are economic, such as existing runway configurations, need for highest possible capacity utilization, availability of gates and ramps, etc. Some are technical such as runway spacing, approach paths and spacing, touchdown points, etc.;

means for the measurement of acceptance rates.

The models permit computer analysis of improvements to existing facilities to achieve higher site capacity. Possible improvements include:

- dual-lane runway operations
- separation between operations on parallel runways
- reducing longitudinal separation standards
- construction changes to satisfy all-weather operating requirements
- high-speed turnoffs

3.6.3 Weather

It is necessary to provide accurate, timely, and operationally meaningful weather information to the users. Special emphasis should be placed on the identification and description of hazardous weather situations. Major improvements to today's system will include:

a. Improved radar detection, identification and tracking
b. Increase in the number and frequency of surface observations
c. Automated collection, processing and distribution of pilot reports
d. Reduction in delivery time of operationally critical weather reports to pilots and controllers
e. Tailoring of weather data to render it more suitable for the user
f. Presentation of real time hazardous weather to the controller
g. Improvements to accuracy of aviation weather forecasts through quality control.

radar vector commands. The integral subsystems of RNAV will provide the aircraft with sufficient information to fly from one designated way-point to another within the terminal area without being told by the controller when to turn. It will also relieve the controller of part of his tracking requirement because of the improved behavior of the aircraft.

b. MLS

This system can be installed anywhere, but is particularly helpful in locations where the currently used instrument landing system (ILS) will not operate. Improved performance of this system will be available in the form of an infinitely variable multiple glide slope and a curved-approach capability. These features will reduce the need for maneuvering to obtain position in the landing sequence and permit utilization of approach paths with minimal noise impact. Use of runways previously closed because of noise abatement restrictions may be possible.

3.6.7 Wind Shear

Three potential near-term solutions to aviation problems created by hazardous low level wind shear are being investigated. They include: development of a ground-based Low Level Wind Shear Alert System to detect shear in the terminal area, development of a Hazardous Wind Shear Advisory Service (in cooperation with the National Weather Service) to alert pilots when strong wind shear conditions are going to affect airport operations, and the development of avionic displays to assist pilots in coping with shear during approaches to the airport.

and absorption of delays.

Specifically, M & S will perform the following functions:

(1) Control the flow of traffic into the terminal
(2) Determine landing order based on the nominal landing time of the aircraft types in the mix
(3) Establish schedule times at various check points to assure proper spacing
(4) Aid the controller by generating recommended commands to satisfy the established schedules.

3.6.9 Ground Control at the Terminals

Currently, the ground control of aircraft at terminals is handled separately from the ATC. Thus, when the pilot gets clearance from ATC for departure to his intended destination (e.g., from the flow control system discussed above), his access from gate to runway is controlled separately. Large taxi queues during peak hours at busy airports are common experiences. These not only result in wasted fuel and inconvenience, or discomfort to the passenger, but also can introduce unwelcome perturbations into the flow control system, thus compounding its problems and reducing its effectiveness.

Little work is currently being done in this area. One problem is that it is at the interface between traffic control functions and airline/passenger interactions, which are controlled by the airlines. However, it is recommended as an area for further study regarding both the severity of the fuel diseconomies involved and for the development or procedures to eliminate ground queues. The latter will undoubtedly impinge upon passenger boarding strategies.

TABLE 3-5. EFFECTS OF NEW DEVELOPMENTS IN OPERATIONS

	TIME FRAME	PQ	PA	CA	FS
WAKE VORTICES	MED	-	-	N	P
AIRPORT DESIGN	NEAR	-	-	-	P
WEATHER	NEAR-MED	P	P	-	P
NOISE ABATEMENT	MED-FAR	-	-	P	M
COMMUNICATIONS	FAR	-	-	-	P
TERMINAL AREA NAVIGATION	MED	-	-	P	M
AIRPORT SURVEILLANCE	MED	-	-	-	P
WIND SHEAR	NEAR	P	P	-	-
SCHEDULING	NEAR-MED	?	?	-	M
TERMINAL GROUND CONTROL	MED-FAR	-	?	-	P

P - POSITIVE
N - NEGATIVE
- - NIL
M - MARGINAL

RQ - RIDE QUALITY
PA - PASSENGER ACCEPTANCE
CA - COMMUNITY ACCEPTANCE
FS - FUEL SAVINGS

It is clear that the implications of the community acceptance problem will likely generate circumstances which are not entirely compatible with improved ride quality and fuel economy, e.g., flight profiles which are considerably longer and more intricate. Also, land use controls and basic economics will probably restrict the number of new airports constructed, while at the same time increased air travel demand will cause congestion both in the air and on the ground at the existing airports. Thus, the problems of passenger acceptance and fuel economy will only be compounded. On the brighter side, the quest for quieter aircraft is bound to have positive effects on passenger acceptance.

As discussed at the beginning of this section, the questions of acceptance must be addressed to several groups of participants in the air transportation systems. Although the time constraints of the workshop would permit detailed consideration only for the passenger and community sectors, an attempt was made to examine the compatibility of the goals and objectives of the various groups. The results are shown in Figure 3-1. Perhaps the most interesting conclusion is the complete lack of agreement between the community perspective and the desires of the human components of the air transportation system.

3.8 FUTURE AIRCRAFT CONFIGURATIONS

Throughout its deliberations the group found it essential to discuss the potential for fuel savings (FS) and ride quality (RQ) to be derived from various technologies in terms of the configurations and missions of the aircraft that would be likely to result. The consensus of the group on this subject was expressed in tabular form which is included here as Table 3-6.

TABLE 3-6. FUTURE AIRCRAFT

TYPE	1990	2000^+
COMMUTER PAX: 50 SPEED: 200 KNOTS RANGE: 300 MI FIELD LENGTH: 4000 FT	- LOW INITIAL COST - CLOSE SEAT SPACING - ADVANCED STRUCTURES - TURBOPROP ENGINES FS SUBSTANTIAL RQ A PROBLEM	- AIR CUSHION LANDING GEAR FS UNAFFECTED RQ UNKNOWN
SHORT HAUL PAX: 80 - 500 SPEED: $M = .65 - .8$ RANGE: 300 - 1200 MI FIELD LENGTH: 400 - 6500 FT	- STEEP CLIMB/DESCENT - CLOSE SEAT SPACING - ADVANCED AERODYNAMICS - TURBOPROP ENGINES - ADVANCED STRUCTURES - ACTIVE CONTROLS FS SUBSTANTIAL RQ A SLIGHT PROBLEM	- ADVANCED POWER PLANTS - CONFIGURED FOR QUICK INTERMODAL CHANGE - ALTERNATE FUEL FS SUBSTANTIAL RQ UNKNOWN
LONG HAUL PAX: 50 - 800 SPEED: $M = .75 - 2^+$ RANGE: 3500 - 6000 MI FIELD LENGTH: 8500 - 10,000 FT	- HIGH PRODUCTIVITY - CONVENTIONAL DESIGN - WIDE BODY FOR SUBSONIC FLIGHT - ADVANCED STRUCTURES - ADVANCED AERODYNAMICS FS SUBSTANTIAL RQ NOT A PROBLEM	- NEW CONFIGURATION - POSSIBLE USE OF LAMINAR FLOW - NEW TURBOPROP ENGINES - ALTERNATIVE FUEL FS SUBSTANTIAL RQ UNKNOWN

FS: FUEL SAVINGS
RQ: RIDE QUALITY

TABLE 3-7. AREAS HAVING MAJOR POTENTIAL FOR FUEL SAVING

	TIME FRAME	RQ	PA	CA
LAMINAR FLOW CONTROL	FAR	N	N	-
PROFAN ENGINES	NEAR	N	N	?
COMPOSITES	NEAR-MED	-	-	-
FLIGHT PATH/GROUND OPERATIONS	NEAR	P	P	N

P - POSITIVE
N - NEGATIVE
- - NIL

RQ - RIDE QUALITY
PA - PASSENGER ACCEPTANCE
CA - COMMUNITY ACCEPTANCE

Fly-by-wire - A control system in which the links between the controller and the control surfaces are accomplished electrically.

"Hard" stability augmentation system - A control system which allows the aircraft to operate beyond its normal limits of performance.

Interference drag - The drag which results from the interaction of flows between the components of the aircraft.

Lift-curve slope - A measure of the variation of lift with angle of attack.

Nacelle - The housing of an aircraft engine.

Redundancy management - The processing of signals from redundant systems.

Structural damping - Decay of vibrations in the structure.

The following sections describe the research areas in detail. For each there is a statement of the problem, a description of research projects, and, in some cases, an appropriate method to be used.

4.2 TRAVEL BEHAVIOR AND DECISION-MAKING

Problem.

One of the major difficulties that the group faced throughout the workshop was developing research ideas in an area where so little solid data is currently available. We do not know how people are making trips, especially trips in which more than one mode is used. In addition, there are virtually no data on how people make trip decisions and whether they are aware of travel alternatives. Finally, research to improve data gathering techniques to supplement questionnaires is needed.

4.2.1 Project I: Taxonomy of Intermediate Length Travel Behavior

The most frequently cited source of data on intermediate range travel behavior is the National Travel Survey (NTS) of 1972 conducted by the Bureau of the Census (7). The NTS queried approximately 25,000 individuals about trips of more than 100 miles taken during the previous year. There are several problems with using the NTS to understand travel behavior:

1. Information is provided only about the longest segment of the trip. If someone walked to a subway station, took the subway to the airport, flew 200 miles, and then took a bus to his destination, the trip would be counted only as a trip by air.

3. Demographic characteristics of travelers such as income, age, type of employment, and availability of autos.

4.2.2 Project II: Analysis of Traveler Decision-Making and Awareness of Alternatives

Of the work that has been funded by DOT over the past ten years, there has been only one nationwide survey of the attitudes of intermediate range travelers. This recently completed study was conducted for the Office of Transportation Economic Analysis (5) and consisted of a home interview that focused on the respondent's last automobile trip of more than 100 miles. The respondents were also asked about their knowledge of travel alternatives, and why they did not use those alternatives. The results of the survey showed that, in general, the respondents were knowledgeable about travel alternatives. Over 90 percent knew where the nearest bus station was located and 70 percent knew where the train station was. When asked why they did not use the bus or train, over 45 percent cited inconvenience in several forms as the reason, including increased trip time, poor location of stations, unsatisfactory schedules, and the requirement to transfer between vehicles. These results are consistent with a recent nationwide telephone survey conducted by AMTRAK which showed that travelers who used their autos to make trips rated convenience as the most important factor. The survey also indicated the importance of economy to bus users and the ability to relax during the trip to train users. We clearly need more of this type of data in order to understand trip decision-making.

Method.

A survey to obtain decision-making and awareness data could be combined with the survey on basic travel behavior. Although a questionnaire is often not the best tool for transportation decisions. Asking consumers to keep travel diaries can often provide insights into decision-making processes.

4.3 MARKETING AND PROMOTION OF TRAVEL ALTERNATIVES

Problem.

The group discussed at length methods to promote the use of public transportation in ways that would appeal to a wider range of travelers. It was agreed, however, that before promotional strategies are developed, marketing studies are needed to identify the groups that the promotions will be aimed at. For example, a family of five with a large van going on a 200 mile trip destined for a rural area is not likely to be influenced to use a train. Initial marketing studies are needed to separate or segment travelers into groups that are more or less likely to change modes. Special appeals can then be targeted to groups that have the greatest likelihood of switching.

4.3.1 Project IV: Identification of the Market for Public Transportation

Can users be segmented into groups that are likely to change modes versus those that are unlikely to change? If so, what are the relevant variables involved in market segmentation? Possible bases for segmentation include:

1. Availability of alternatives
2. Frequency of travel
3. Prior use of common carrier
4. Demographic characteristics such as income and auto ownership.

least three areas where research projects or demonstrations are needed:

1. Improving the availability of public transit
2. Providing more service alternatives and
3. Making current systems easier for consumers to use.

The technologies needed for these changes have already been developed. What is needed are not new technologies but systems that meet travelers' needs better.

4.4.1 Project VI: Methods to Improve Availability

It was noted that buses and trains capture their largest share of the market in intercity travel between large urban areas that are 100-300 miles apart. For example, bus and rail combined account for about 25 percent of trips between New York and Washington but only about 5 percent of trips between Washington and Boston. When trips do not begin or end in a major city, virtually all trips are made by auto. Furthermore as noted above, auto users reported that they did not use public transportation because it was inconvenient. It would appear, then, that there is a market for public transit for intermediate length trips if public transit were available to a larger number of people.

Method.

One obvious research possibility here is to investigate the use of feeder services to main line systems. The short takeoff and landing (STOL) commuter airline demonstration between Montreal and Ottawa is an example.

The purpose of the demonstration was to show that STOL aircraft are acceptable to business travelers. The service was designed to allow business people to split their working

35 to 55. These are the people who are now using their autos to make trips. Unless public transit can be modified to appeal to these people, the proportion of travelers using their autos will increase even more. Multiclass service may provide a means of increasing the use of public modes. Research and demonstration in this area should be encouraged.

Method.

An example of this type of service is currently being demonstrated in Canada. A "luxury" bus has been introduced between Montreal and Quebec City, featuring a hostess, meal service, three abreast seating, a telephone, and a reservation system. Four buses a day run in each direction. Use of the service has been good, especially by business travelers. The bus company has purchased two more buses and expects ridership to continue to increase. Funding needs to be provided for similar demonstrations in the United States.

4.4.3 Project VIII: Service Management

In the past, our understanding and data regarding travel choice have been derived from responses to transportation improvements such as the interstate highway system, which have enlarged the area within which individuals could travel to obtain benefits at the trip's end. The transportation alternatives now being considered, however, have as their objective improving service to existing developed areas and saving energy. Therefore, we need to increase the quality of service of existing transportation systems. One obvious area where research could have an immediate payoff is in the improvement of passenger communication and information aids such as providing scheduling, routing, transfer and fare information. The form of information can be as simple as higher quality printed matter and better signage, or as

5. GROUP D

IMPLICATIONS OF INCREASED SIZE DISPARITY FOR GROUND TRANSPORT FREIGHT AND PASSENGER VEHICLES USING SHARED GUIDEWAYS

5.1 INTRODUCTION

Since ground transport modes represent a varied group of vehicles and surface types, it was agreed by the members of Group D that three subgroups should be formed:

Subgroup D-1: Rail
Subgroup D-2: Highways
Subgroup D-3: Advanced Concepts*

Both the rail and highway groups focused on conventional transport services; the advanced concepts group confined itself to technologies that are not yet in revenue service.

Because of the obvious differences between the three subgroups, most of the time was spent in independent meetings. They did, however, coordinate their activities through short joint sessions and interchanges between the subgroup chairmen throughout the conference.

Although the report of each subgroup is presented separately, the general objective of each group was the same. Specifically the goals of group D were to:

1. Identify the motivating factors leading to increased vehicle size disparity,
2. Identify the effects of vehicle size disparity on vehicle guideway maintenance,
3. Identify the resulting ride quality and level of service changes,
4. Identify the resulting technological trends (e.g., the design of lightweight/high-speed passenger

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* The members of each subgroup are shown in Section 5.6.

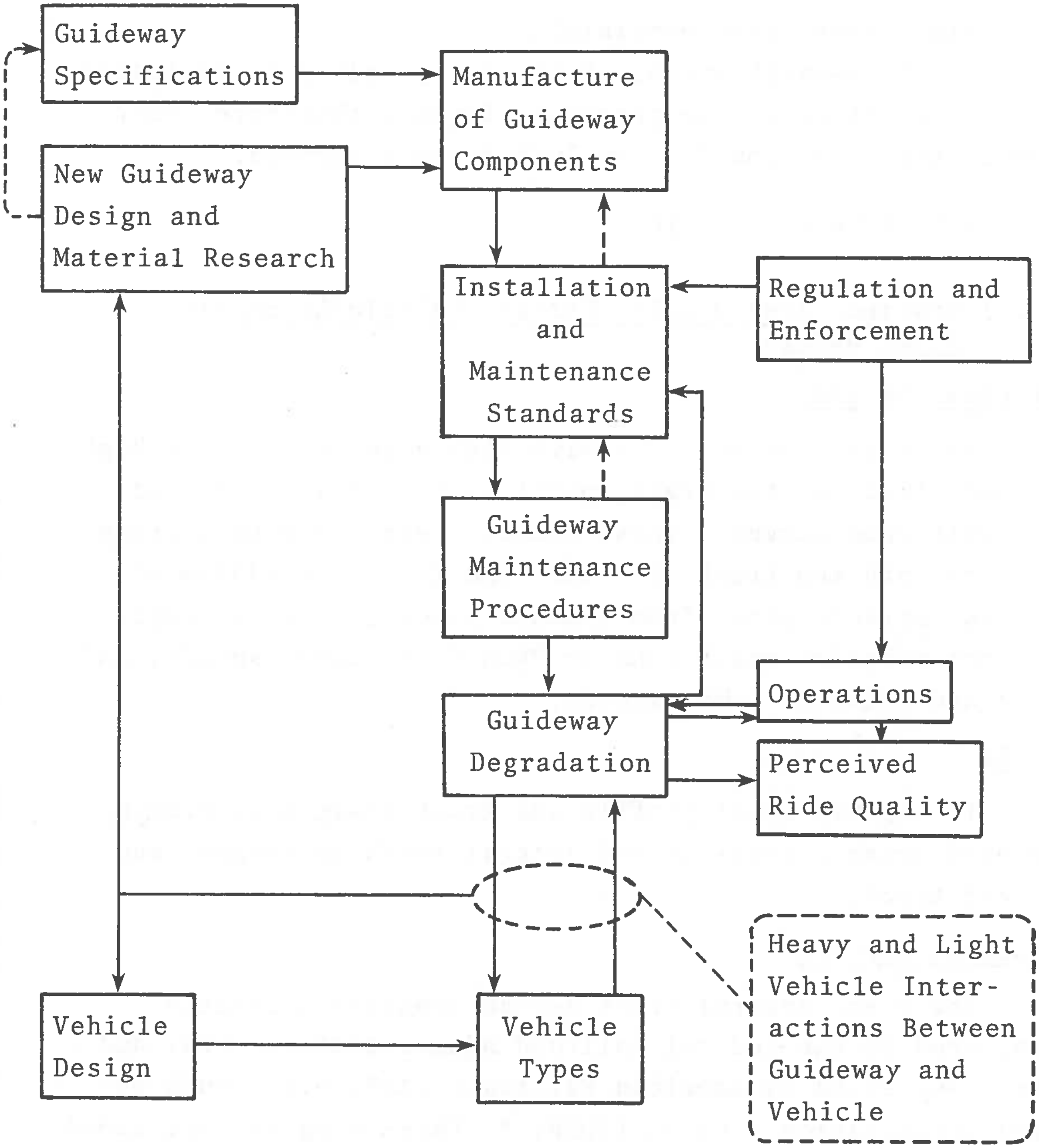

FIGURE 5-1. RELATIONSHIP BETWEEN FACTORS DISCUSSED

Pay-off vs. Risk

The pay-off is reduced vehicle and track maintenance costs, higher speeds, increased safety and increased operating efficiency; i.e., the pay-off is very high. The technical risks are moderate; some fundamental theoretical work is required. The major risk in implementation is economic; i.e., will the railroads perceive the benefits to warrant the costs?

Proposed Approach

The recommended approach is a combined wheel/track suspension design program aimed at reducing wheel/track dynamic loads. This will involve testing combined with improved predictive analytical tools.

Level of Effort

30 labor-years.

Time Frame

3 years.

5.2.2 Research Area D-1.2: Track Research

Problem Statement

The great disparity due to differences in design, loading and operations which exists between passenger and freight systems has created the need for new maintenance requirements for track.

Goals

1. Establish limits for the loads imposed on the track due to the dynamic interaction between vehicle and track.
2. Develop design requirements for vehicles and tracks which incorporate the interaction that one imposes on the other.

4. Develop proper cost accounting for track degradation induced by vehicle loading cycles.
5. Restrict vehicle dynamic loads.
6. Develop new track materials.
7. Expand components research.
8. Improve designs for weak areas of track
    - Spirals (entry and exit)
    - Turnouts and other track work areas
    - Bridge approaches.

5.2.3 Research Area D-1.3: Rail Passenger Vehicles

Problem Statement

Real world economic limitations demand that rail systems run on less than ideal track. Lateral lurching as experienced today is unacceptable. Maintainability is not currently included in design goals. Regulations currently restrict the use of certain technological developments (e.g., tilt systems).

Goals

To provide improved ride quality and level of service with existing track.

State-of-the-Art

Passive suspension systems provide reasonable ride vibration environment with longer trip times. Tilt systems are available which provide higher speeds on curves and hence reduced trip times; however, current regulations restrict the use of these systems.

Pay-off vs. Risk

Higher passenger acceptance and lower maintenance costs should provide a good pay-off.

The risk of technical development is low. However, the uncertainty of benefit (from increased utilization) vs. the

An appraisal of the condition of the nation's road system has not been made and highway authorities are not in a position to predict the likely state of repair of the nation's road system at any future date, or the effect of any incremental increase or decrease in maintenance expenditure.

Goals:

Conduct research leading to the establishment of road performance standards.

State-of-the-Art

Measuring instruments are available (e.g., roughometers, deflectometers, photographic survey vehicles, skid trailers, weighing-in-motion scales) to conduct surveys of the quality of highways. However, the techniques have been proven on less than a national scale and not in a combined program. Consequently, vital data is not available. A mathematical simulation of a small maintenance division was attempted, unsuccessfully, by the National Bureau of Standards. A similar endeavor is currently underway, for an even smaller maintenance division, at Louisiana State University.

The sampling concept has been tested on a limited basis: (1) in the KAB* Study (conducted by cooperating states and the Transportation Research Board), (2) by the Ohio Department of Transportation for the purpose of allocating maintenance funds, and (3) by the Pennsylvania Department of Transportation when it established a maintenance management system.

Proposed Approach

PHASE I

A research team, equipped with measuring instruments, will develop a stratified sample of roadway segments to

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*See Glossary at the end of this section.

declining. This information would aid vehicle designers in providing vehicles which will perform adequately on the nation's road system.

Transportation authorities will also be in a position to establish funding levels and establish maintenance regulations with confidence.

The pay-off is high and the risk of failure is low for Phase I, but the objectives of Phase II may not be attainable.

5.3.2 Research Area D-2.2: Performance Standards and Use Restrictions for Large Freight-Carrying Vehicles

Problem Statement

The economic pressures for increases in the labor and capital productivity of highway transport, in conjunction with height and width constraints on cargo compartments, mean that productivity increases are synonymous with increases in the number of trailers hauled by a single tractor. In other words, substantial motivation exists for developing and authorizing the use of "highway trains." Since the physics of articulated, pneumatic-tired tractor-trailer systems dictates that the damping of the oscillatory modes of motion of these systems decreases with an increase in the number of linked articulated masses and with increased speed, it follows that road-use laws and performance standards in directional stability and rollover immunity must be developed and coordinated so as to preserve the operational integrity of highway transportation. Experience shows that the "highway trains" in common use today account for a disproportionate share of traffic blockage, even on the highest quality portions of the road network. The existence of the jacknifing phenomenon, together with the lower levels of rollover immunity exhibited by large tractor-trailer systems, constitutes an increased potential for upset, a traffic disruption which is further aggravated by the difficulty of removing large, upset vehicles from the travelled way.

4. Identify the manner in which road-use laws promulgated by the various states determine the final configuration of large freight-carrying vehicles without simultaneously requiring that these configurations meet certain minimum performance standards.
5. On the basis of hypothetical performance standards for (a) directional stability and control, (b) braking, (c) rollover immunity, determine the alternative methods for achieving these performance standards and evaluate their relative cost-effectiveness and the resulting benefit/cost ratio to highway freight movement.

5.3.3 Research Area D-2.3: Impact of an Increased Size and Weight Disparity on the Safety of Highway Operations

Problem Statement

The desire to conserve fuel and to increase the productivity of freight transport leads to a growing disparity in size and weight of the vehicle population using the existing highway network. On the basis of current experience, it seems reasonable to hypothesize that the safety level of highway transport will be negatively affected by this size and weight trend. Accordingly, studies should be undertaken to identify and quantify the various ways in which these size and weight differences make demands on highway design, traffic control, and vehicle design.

Goals

Identify the various mechanisms by which a large variation in size and weight leads to a greater potential for loss of control or a greater probability of injury (or fatality) in the event of a collision or crash. Analyze the mechanisms in order to develop guidelines for vehicle and highway

Proposed Approach

1. Given a specific level of road roughness (as produced by traffic and environmental causes), are smaller passenger vehicles (at the low end of the size and weight spectrum) likely to suffer significantly in their road-holding capability? Can this decrease be quantified and calculated on the basis of physics and is it possible to confirm this calculation by means of accident data?
2. Will the increased sensitivity of small, light cars to road roughness (resulting in reduced ride quality) produce a significant impact on the safety record by causing increased operator fatigue with a corollary loss in performance control and alertness? Will the vehicle configurations that evolve from the objective of making trucking more productive result in a degraded environment for the freight-vehicle operator such that his control performance is reduced? If so, how can this trend be offset by design practice and what are the dollar investments required to recoup losses in truck ride quality caused by design for increased productivity?
3. What are the relationships between increased vehicle size and weight and the increased potential for rutting and subsequent increase in the splash and spray generated during set road conditions?
4. How will a traffic mix consisting of a vehicle population characterized by a broader distribution of (a) sizes and weights and (b) acceleration performance levels, influence highway operations (headway maintenance, passing, entry into the traffic stream, etc.)? Will this influence on operations be negative from a safety point of view and, if so, can this influence be quantified for the

the rate at which the investment is depreciated, and the costs associated with traffic regulation and enforcement.

5.3.5 Research Area D-2.5: Overload Detection and Enforcement

Problem Statement

Accurate and comprehensive measurement of truck weights is essential to (1) establishing the influence of loads on pavements, (2) conducting pavement management programs, and (3) insuring that highway costs are fairly apportioned to highway users and nonusers. However, current measurement and enforcement techniques, e.g., weighing "vehicles in motion," portable scales, fixed scales, and the use of bridges as scales are not adequate to the task at hand.

Accordingly, this workshop fully supports current efforts by state and federal authorities to improve overload measurement techniques and enforcement efforts. Workshop personnel, however, believe that the problem is well-known and is currently receiving adequate attention.* Inclusion of this item in the report serves to indicate our support for the research that is going on in this area.

5.4 SUB-GROUP D-3: ADVANCED CONCEPTS

5.4.1 Research Area D-3.1: Operational and Economic Considerations for Dedicated Lanes for Common Carrier Passenger and Freight Traffic

Problem Statement

One solution to the problem of heavy trucks and buses mixed with smaller cars is to restrict these vehicles to a dedicated lane. This gives rise to a host of questions:

1. How do you restrain drivers from changing lanes?

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*DOT Cost Allocation Study, Public Law 95-599, Nov. 6, 1978, Federal Aid Highway Act of 1978, Section 161.

the use of a noncontact suspension, such buses could operate at even higher speeds.

Goals

1. Determine reliability levels for large truck combinations operating on single-lane guideways.
2. Determine acceptability to the trucking industry of operation in restricted guideways and/or line-haul operation at night only.
3. Explore various lane-configuration options (i.e., barriers, buried cables) for electronic guidance, trucks and buses operating throughout the day, one-way operations, etc.
4. Construct an overall cost-accounting procedure whereby desirability of the above alternatives could be assessed. This accounting should examine the costs associated with providing designated lanes capable of supporting these heavier vehicles.

Pay-offs

1. A presentation of the costs and benefits of various alternatives for restricting trucks and buses to exclusive lanes.
2. A determination of the most likely lane-configuration alternatives which would lead to greater focus for future research.

Priority

Various members of the transportation community, including the Secretary of Transportation, have brought up the notion of restricting large trucks to certain lanes or corridors. It is essential that the broadest possible range of options for accomplishing this with the least harm and/or maximum benefit to the nation be explored.

Level of Effort

This research task is estimated to be a 5 labor-year effort.

3. The capability for negotiating curves at increased speed relative to rail and highway systems, thus providing the potential for increased productivity.
4. The capability to use non-petroleum-based fuels.
5. The potential for low noise and pollution.
6. The potential to produce low vibration levels and accommodate guideway irregularities.
7. The potential for reduction in maintenance costs.

Goals

The research objectives are:

1. To assess the requirements for shared guideways passenger-freight service using advanced systems, e.g. -
   - Vehicle design
   - Guideway design
   - System operation.
2. To determine the potential for operational characteristics of these advanced systems to influence the productivity and cost of passenger and freight service.
3. To identify and evaluate what kinds and types of freight services mate well with advanced system characteristics, e.g. -
   - The effect of positive retention of the vehicle in the guideway on various safety issues
   - The ability to handle fragile freight
   - The potential advantages for handling hazardous materials.

Pay-Offs

This research will provide the basic information required to assess the potential of advanced systems for providing freight-passenger service, and will identify the specific applications which show the most promise.

Before and after guideway profile data for the PTACV have been collected by the Federal Railroad Administration and maintenance records for the vehicle exist.

Pay-off vs. Risk

This is a medium pay-off, low risk project. The direct pay-off is only medium because the analytical results are logically consistent. Nevertheless, results based on actual data might provide needed confirmation for policy decisions. There is a high indirect pay-off in cooperating with foreign programs which are aggressively pursuing levitated system technology - e.g. $50 million annually.

Level of Effort

Two labor-years.

Time Frame

One year.

5.4.4 Research Area D-3.4: Automated Intercity Rubber-Tired Freight and Passenger Guideway Systems

Problem Statement

The Urban Mass Transportation Administration (UMTA) has done a considerable amount of research on automated vehicles for urban applications. However, there are numerous advantages to be seen for intercity application, particularly for shared passenger/freight operations on exclusive lanes. The potential for this technology for the moderate speed range applicable to the intercity market should be assessed.

Pay-off and Risk

Technological risk is very low since it would represent an extrapolation of technology which is currently being developed. Pay-off would be moderate in that it would increase the understanding of intercity transportation options.

PTACV - United States Protolyon Tracked Air Cushion Vehicle tested at Pueblo CO, test track.

5.6 SUBGROUP STRUCTURE FOR GROUP D

Group D - Implications of Increased Size Disparity for Ground Transport Freight and Passenger Vehicles Using Shared Guideways

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Recorder: Bradley Hargroves
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Subgroup D-2: Highways

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APPENDIX A

MEMBERS OF TRB COMMITTE A3C11

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