Conference Proceedings

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AMERICA'S FREIGHT SYSTEM IN THE 80's AND 90's . . . . but how to get there?

A CONFERENCE PRESENTED BY THE

U.S. Department of Transportation
Transportation Systems Center
CAMBRIDGE, MASSACHUSETTS

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FOREWORD

This document contains the proceedings from "America's Freight System in the '80's and '90's . . . But How to Get There?", a two-day conference sponsored by the U.S. Department of Transportation, Transportation Systems Center and by the DOT Office of R&D Policy and the Federal Railroad Administration. The conference was held at the Center in Cambridge, Massachusetts, on December 1 and 2, 1976. Its focus was primarily on future technological needs, opportunities, and priorities in the context of major, long-range (that is, through the year 2000) economic and social concerns.

In attendance were distinguished panelists and speakers from the physical and social sciences, within the transportation field and without. These representatives from government and industry assessed the potential of technological advances in intercity freight transportation. Through discussion and debate, the conference strove to:

- Bring into focus the long-range technological needs of – and opportunities in – intercity freight transportation.
- Identify high-profitability, high-payoff areas that should receive concentration.
- Consider the urgency of the need for more technological research and application.
- Explore ways of overcoming existing economic and institutional barriers to technological development.

In short, the aim of the conference was to provide key parties with valuable information they need to move ahead with future freight technology-related plans and programs. It is my belief that thanks to the speakers, panelists, and conferees that aim was well served.

On behalf of my colleagues in the United States Department of Transportation I would like to extend sincere thanks to all the speakers, moderators, panelists and participants involved in this conference for making it a great success. All of us in DOT are extremely pleased with the results of the conference; we believe that they will be of great value in helping us shape the direction of our future research work in freight transportation systems and technology. We are hopeful that the conference will prove equally valuable to all concerned.

James Costantino
Director, Transportation Systems Center

CONFERENCE PROCEEDINGS

AMERICA'S FREIGHT SYSTEM IN THE 80's AND 90's . . . BUT HOW TO GET THERE?

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Dr. James Costantino
Director, Transportation Systems Center
U.S. Department of Transportation

Prior to assuming this post at the Transportation Systems Center in January 1976, Dr. Costantino served as Executive Assistant to the Deputy Secretary of Transportation for two years. Before that he was the Department's Secretarial Representative in Federal Region III, headquartered in Philadelphia. Dr. Costantino also served as Director of Technical and Management Support for NASA's Office of Manned Space Flight and as a mechanical engineer with the Federal Aviation Administration. In 1974, he was awarded the secretary's Meritorious Achievement Medal while at DOT and also holds the NASA Apollo Achievement Award.

WELCOME ADDRESS

"WELCOMING ADDRESS TO 'AMERICA'S FREIGHT SYSTEM IN THE 80's AND 90's . . . BUT HOW TO GET THERE?'"

Good morning. Welcome to Cambridge and to the Transportation Systems Center. It is a pleasure to see so many people that are critical to our nation's freight industry here with us today. We appreciate this overwhelming response to our invitation and we look forward to your active participation during the following two days. I also want to extend a special welcome to the graduate students and faculty from the engineering and transportation programs of several universities who have joined us today. Transportation is an exciting venture and I hope that the proceedings of the next two days, in addition to our new faculty residency program, will open more doors into this profession for you.

Transportation in this country is a $250 billion a year business, depending on who's doing the counting. Over the past 20 years, about $2.5 trillion have been spent shuttling people and goods throughout the United States. With figures like that, even a 1 percent inefficiency costs $2 billion to $3 billion a year! And you and I know that inefficiencies most certainly do exist. There are many of them.

So – what should we do about it? The first thing we can do is to recognize that many of the programs, objectives, and approaches that were desirable or appropriate in the 50's and 60's may well be undesirable in the 70's, 80's, and beyond.

The second thing is to recognize that technological change for its own sake is not enough. Research and development activities demand more . . . that social, economic, and political complexities and realities be taken into account.

It was in that spirit that the Department of Transportation created the Transportation Systems Center here in Cambridge little more than six years ago. The Center is a research and development facility staffed to accommodate a wide spectrum of technical and socioeconomic problems involving every one of the elements of the department . . . the Federal Aviation Administration, the U.S. Coast Guard, the Federal Highway Administration, Urban Mass Transportation Administration, Federal Railroad Administration, St. Lawrence Seaway Development Corporation, the National Highway Safety Administration, the Alaska Railroad, the Materials Transportation Bureau, and the Office of Deepwater Ports. Our annual budget at this Center has risen to over $60 million in six years, of which more than half is funneled to private industry and academic institutions throughout the country, and even some to foreign countries.

Our staff — of about 650 men and women — includes engineers and scientists of all disciplines. It also includes economists, community planners, sociologists, mathematicians, psychologists, and even transportation legal experts that we apply in a total systems approach to today's and tomorrow's transportation problems.

This conference, one of several in a series on major transportation topics held here at TSC, will focus on the strengths, problems, and requirements of intercity freight transportation over the next 25 years. The emphasis will be on the technological responses to these challenges that can be realized late in this century.

We are privileged in having here for the next two days an outstanding group of transportation speakers and panelists as well as a conference format designed to elicit the key freight issues and possible solutions. I want to make it clear at the outset that the federal government will not be trying to sell you anything during the next two days. Rather, we want to hear from you so that we can be better informed as we work on major freight transportation projects here at TSC and in Washington. Nevertheless, I hope that the message of technology will not be lost in the series of dialogues we have planned.

I want to ask each of you to be an active participant in this conference. Our objective in the next two days is to focus on the long-range technological needs of — and opportunities in — intercity freight transportation. I do not expect that we will touch on all of the high-profitability, high-payoff areas that should receive concentration; I do hope that we will touch on the major ones, particularly those in which more technological research and development work may be needed. I hope that as part of our conference activities, we will also explore ways of overcoming existing economic and institutional barriers to realizing the full capabilities of our nation's freight transportation system, rather than just acknowledge that they exist.

Before introducing our keynote speaker, I would like to leave you with a quote from a gentleman whose book, Fundamentals of Operations Research, was the first one most of us read on the subject, and who is still teaching and writing at the University of Pennsylvania. His name is Russell Ackoff and his work is frequently quoted. This quote may be particularly appropriate for our conference today. Dr. Ackoff wrote "We waste too much time trying to forecast the future. The future depends more on what we do between now and then, than it does on what has happened up to now. The thing to do with the future is not to forecast it but to create it. The objective of planning should be to design a desirable future and to invent ways to bring it about."

Our keynote speaker today is the Honorable John W. Barnum, the Deputy Secretary of Transportation, who is certainly no stranger to the majority of you in the transportation business. Secretary Barnum has traveled the width and breadth of this country . . . indeed of the world . . . bringing the federal government's transportation message to all who would listen. Mr. Barnum played the government's key role in drafting the Regional Rail Reorganization Act of 1973 and the Rail Revitalization and Regulatory Reform Act of 1976. He has served with three secretaries of transportation and has been the general manager of a department having over 100,000 people scattered throughout the world. Prior to being named deputy secretary in May 1973, Mr. Barnum served as the department's general counsel for three years.

An undergraduate of Yale University; a graduate of Yale Law School; an editor of Yale Law Journal; a former editor and publisher of a Connecticut newspaper; a former securities and exchange analyst with the First Banking Corporation in Tangier, Morocco, and later a registered representative with Bache & Co. in London and Paris; a former partner in the New York law firm of Cravath, Swaine and Moore; and a close associate and good friend of transportation, the Transportation Systems Center, and many of you personally, Mr. Barnum brings to this conference the accumulated wisdom, experience, and penetrating analysis that has served the department so well for six years. It gives me a great deal of personal and professional pleasure to introduce the deputy secretary of transportation, the Honorable John W. Barnum.

The Honorable John W. Barnum
Deputy Secretary of Transportation
U.S. Department of Transportation

Mr. Barnum assumed the number two position at the Department of Transportation in July 1973, after serving as the Department's general counsel for two years. Prior to joining DOT, Mr. Barnum was associated with the New York law firm of Cravath, Swaine & Moore. He had been a partner of the firm since 1963, working principally in general litigation and antitrust. A graduate of Yale University and Yale Law School, he was an editor of the Yale Law Journal.

KEYNOTE ADDRESS

"KEYNOTE ADDRESS TO 'AMERICA'S FREIGHT SYSTEM IN THE 80'S AND 90'S . . . BUT HOW TO GET THERE?'"

Several years ago I interviewed Martin Clement, who had been President of the Pennsylvania Railroad during the late 30's and 40's, in connection with the government's antitrust case against General Motors for monopolizing the locomotive industry. He was one of the prospective witnesses and I was counsel for General Motors. (My client, incidentally, was the gentleman who is going to speak to you this evening, Dick Terrell, who was then General Manager of EMD.) General Motors' defense for having some 80 percent of the market was "best product," and indeed in the late 40's and 50's General Motors did have a "better idea." As late as 1949 the manufacturers of steam locomotives were saying "steam will never die," and each railroad was designing its own custom-built steam engine. General Motors introduced the diesel-electric locomotive – and there was one model – and it was black. Shades of Henry Ford. And of course it beat the pants off steam locomotives for both cost and operating expense.

After Mr. Clement had given me his own explanation of how General Motors had attained its market share, he threw in a little philosophy. At the turn of the century, he observed, the nation's best technical students were studying civil engineering and going out to build the railroads of the nation. Railroading was the boom industry of the times.

Twenty years later, he continued, our best young technical minds were studying mechanical engineering and going off into the automobile industry, which was then taking off. And by the 40's, of course, aviation had captured the imagination of young America, and since then it has been computer technology and space.

The future of transportation in America depends significantly on the input of the technical community, and that in turn must depend significantly on the next generation of technically trained engineers, economists, and social scientists. To that end, we have a university research program to involve students as well as professors in transportation issues, technical and otherwise, not only for the purpose of getting help with respect to a particular issue, but also to interest today's students in solving the transportation problems of tomorrow.

But the amount of money we are able to dedicate to that particular program is relatively small. A more likely avenue of stimulating interest in technology for transportation is, first, by connecting up advanced technology with the existing transportation infrastructure, as living proof that transportation technology is not only fun and exciting in itself, but that it finds its way into the system. And secondly, by holding and publicizing the product of conferences such as this, to show that there is still much room and need for improvement where innovative minds can find productive challenges.

This conference focuses on the desirable directions in which the nation's freight system can develop in the next 25 years or so. Much work is going forward on the problems of today, but it is vitally important that we also continue to look ahead. For one thing, we need to understand the future implications of current decisions. We don't want to make investments that are apt to become obsolete or prematurely close off future options. We don't want today's system to become tomorrow's problem.

Moreover, the time it takes for an idea to travel from the concept stage through the development, design, and implementation process typically can be several decades. If we are concerned with having a viable freight system in the year 2000, now is the time to think about what that system could look like; what technologies need to be explored; and what other policy, regulatory, and institutional issues need to be addressed to get ready for it.

The benefit of this conference will be the direction and suggestions you can all lend on where the government should be focusing its continuing support for improving the longer range intercity freight arena. We are more concerned today than ever about the quality of service, not only as seen by the operators, shippers, and users, but also by the public at large. We hope the next two days will highlight ideas for high productivity, high payoff, and, hopefully, high profitability – ideas which could lead to a better, more efficient, more environmentally acceptable future in moving freight.

By the year 2000, we will see the results of many significant demographic shifts, some of which have only just started. People will be migrating to rural areas – the reverse of a long-term trend up to 1970. They will be more widely dispersed than ever. There will be a continuing trend to live and work in the South and West. This, of course, will result in a greater need for a diverse freight movement system. People will be more affluent than ever – therefore needing and desiring more goods movement than ever before.

These demographic trends and the resulting shifts in the patterns of production and distribution systems indicate that at some future time some of our current transportation infrastructure might have to be abandoned – a phenomenon that we are already seeing on some rail lines in this country. Adjustment of the transportation infrastructure poses two types of challenges: redefining the contributions of less important parts of the existing system, and facilitating the investment in new or revised modes.

Coping with our energy and environmental problems also will be a significant challenge for all of us in the future. Transportation, as you know, accounts for half of our annual petroleum consumption. Much of this at present comes from foreign sources and, as a nation, we are committed to reducing that dependence.

Although the largest part of transportation's petroleum consumption goes to automobiles and other forms of passenger transportation, the growing public concern for our massive energy consumption is leading us to consider new ways to be energy efficient in freight transportation. Rail electrification is one major research area, since it appears to offer the most feasible means to use coal or nuclear power for intercity movements of general freight and passengers. But the costs of electrification are high – estimated at $150,000 per track mile – so we must be selective in determining which lines warrant such investments. We now estimate that it will cost about $4 billion to electrify the approximately 20,000 rail miles that have sufficient traffic density to realize substantial benefits from electrification. Other costs, such as locomotives and track modifications, could make the price tag closer to $5 billion.

Research on electrification also promises benefits for urban transportation. Applications of new flywheel storage technology to urban rail rapid transit, for example, indicate the potential to reduce fuel consumption by up to 25 percent, as well as reducing noise and exhaust emissions.

In the highway area there is growing concern for more energy-efficient trucks. The future may yield viable flywheel, electric, or dual mode technologies for urban highway freight movements. For intercity movements, improved internal combustion engines and diesel engines will almost certainly result from current studies DOT is conducting in conjunction with the Federal Energy Administration and the Environmental Protection Agency. Research here at TSC has also focused on other energy-efficient devices such as drag reducing and new carburetion equipment.

Also in the environmental area, pollution control will continue to be a concern and will result in modifications to the types of power plants that make the freight in this country move. Noise considerations will receive increased attention and studies of noise barriers, quiet tires and wheels, and mufflers and engines will continue. The use of land for transportation corridors has a significant impact on adjacent urban, rural, and suburban areas and the land-use issue will receive closer scrutiny as our nation's transport network expands.

The financial health of transportation industries is another area of primary concern. As you know, this administration has proposed reform of the economic regulatory system under which our rail, aviation, and motor vehicle companies operate – and Congress thought it had enacted significant reforms with respect to the railroads. Unfortunately the ICC disagrees.

We find the evidence overwhelming that excessive regulation prevents efficient, economical operations, and we view reform as a necessary prerequisite to a healthy transportation industry. But such reform really only lays the groundwork, allowing proper scope for technological and operational advances. Indeed, work in this entire economic and regulatory area needs to continue in order to pave the way for technology to have the full impact that it can to improve the nation's freight system. Without the removal of some of the regulatory and institutional barriers to innovation, there will be less stimulus to innovate.

On the other hand, some hardware and operational innovations are clearly possible within the present form of the industry and could yield significant productivity gains within the existing structure. The current financial situation facing the railroad industry is so critical that short-term payoffs are urgently needed in the form of procedures and methods that can lead to more efficient use of the rail industry's equipment and plant, as they now basically exist.

But I would stress again the need for basic regulatory reform, which in practice means more competition. Competition has been shown time and time again to be the most reliable and effective spur to all sorts of improvements, including those that stem from the wise application of technological possibilities.

I think that the government – the Congress as well as the regulatory agencies – has been at fault for trying to treat naturally competitive transportation industries as if they were utilities. Through the application of entry limitations, the government has created a monopoly or semi-monopoly situation, making it then incumbent on the government to impose limitations on profits. Giving government regulators the final word on where the transportation companies can market their services and the prices they can charge means, in effect, that government is substituting its judgment for the natural allocations and decisions of the marketplace. The government's burden is to administer the entry and exit limitations so that the public is well served, and at the same time to administer the limitations on profit so that the carriers earn precisely the right amount – not too much or not too little.

This is a heavy burden, and asking the government to be adept and even-handed in striking these difficult balances is simply expecting too much. Whatever one may say about the quality of service which the transportation industry provides shippers and travelers, and in almost all respects I think we can fairly state that America has the best transportation in the world, the parlous financial condition of the railroad and air carrier industries is vivid proof that government is not doing very well the job that it has arrogated unto itself by perpetuating and expanding restraints that might have been justified in their nascent form and under other circumstances but are not justified today.

Moreover, nobody in his right mind could claim that even the most even-handed government regulator could achieve the efficiencies in the use of capital which result from a purely competitive market where hundreds of individual entrepreneurs are striving to maximize profits. The proper question is: "What limitations on pure competition are absolutely necessary to assure adequate as well as efficient service?"

Government policy that would foster competition between transport enterprises and modes more effectively should lead to far better and more timely application of technology in the solution of transportation problems.

In the next two days this conference will address many of the ways that technology should, could, and can help to meet our future freight transportation needs. Let me take just a few more minutes to touch on some of the areas that offer promise.

First, however, I should say that by "technology" I do not mean just hardware or software developments. We also include the spectrum of operational improvements that can be achieved by doing things in a different, more productive manner. Basically, then, technology is a way – hardware, software, or operational – to make the freight system more economical, effective, and efficient.

There are some technological areas that offer tremendous promise in fulfilling our goals for freight system improvements. I feel that intermodal or multimodal operations offer the most promise. The freight transportation industry needs to explore these operations in far greater depth and with far greater diligence.

For every transportation mode, there is some set of circumstances under which it is superior to any other alternative. When it operates under conditions that are outside this "window" of optimal performance, it is less satisfactory. Where a movement of goods has some portion of the journey outside the optimal window of the selected mode, then a transfer to a better mode should be considered. Whether such multimodal movement is preferred will depend on whether the cost of transfer — including time — is less than the additional cost of operating non-optimally for that portion of the journey.

We believe that all will benefit from working together cooperatively in integrated service, but each element must take some different steps.

In the rail and truck industries possible improvements to the freight network can be divided into several steps. The first is selective rehabilitation of the existing physical plant (guideway and terminals) plus operational changes facilitated by freight car management systems.

A second step is multimodal containerization, coupled with changes in operation of terminals. The yards could use more automated processes for containers; the loading and unloading between rail cars and trucks could be done simultaneously on a number of cars so that stop times are minimized. Shorter trains could increase frequency of service and if operated point to point could decrease the impact on yard operations. Automation is the key to many of these advances.

The next step is a higher speed network. This could be achieved, obviously, by the development of improved physical subsystems, but it could also be achieved by the elimination of restrictive operating policies. The resulting higher productivity might more than outweigh higher equipment costs. Small, lighter locomotives would produce less track damage. The network would emphasize medium-/long-haul container shipments and could be compatible with passenger operations.

A related area in which I feel technology can have a tremendous impact is the rail and general freight terminal information and control systems. Rail cars spend about two-thirds of their time stopped in railroad yards — about 20 percent of the time under shipper control — and about 12 percent of the time moving. About half the time that the cars move they are empty. That doesn't seem particularly efficient, does it? A lot can be done in the rail terminal area to speed up operations. In major rail terminals which act as gateways and points of exchange for a number of railroads, the problems of track control and efficient operational management are compounded. The Chicago rail terminal, which embraces some 27 separate railroads, is a prime example of such a management headache.

There is a major opportunity to improve the process of interchanging freight cars and managing the major terminal gateways in the railroad systems. Lack of compatibility and connectivity of the various management information systems used by the different railroads could limit the future national effectiveness of such systems to all users. Systems in terminals to improve management and control are a key area of research of the Federal Railroad Administration, the Transportation Systems Center, and, of course, the railroads themselves.

The transportation of freight by means of pipeline has been the subject of research for many years, yet this mode has only recently attracted the attention of transportation planners and policymakers. There is a wide variation in the available knowledge and operating experience concerning the various forms of freight pipelines. Some are in the stage of laboratory studies, while other types are used in commercial applications. Commercial experience the world over has proved the feasibility of transporting coal and various mineral ores by means of slurry pipeline. Experience with pneumatic pipelines is also extensive, although these applications have involved only very short distances. Hydraulic capsule pipelines are still in the research and development stage and have yet to be used in a commercial application.

Freight pipelines are a developing and promising mode of transportation. Further research and development will be required before a state of technological maturity comparable to other freight transportation modes is reached. The technical problems do not appear, however, to be insurmountable and freight pipelines are likely to see increased application in the future.

The movement of freight by truck has become more and more obvious on our nation's highways in the last decade. Part of this has resulted from the abandonment of shorter low-volume railroad lines. Significant growth of intercity truck freight shipments has occurred especially where the value of the transported commodity is high or it is of a fragile or perishable nature. To shippers of these commodities, speed and flexibility of delivery are important considerations.

There are a number of promising areas for technological development in the highway and truck field. Longer and heavier tractor-trailer combinations deserve in-depth study. An argument against them can be made because they could cut into the competitive advantage of the other modes, lead to much more costly highway construction and maintenance, and raise another generation of safety issues. However, concern for the ultimate efficiency of the nation's freight transportation system dictates that this area be carefully investigated. If the true cost of operation, including highway user costs, can be reflected in the taxes paid by truck operators, and if safety, noise, and emission goals can be met, the demand for the particular service required should then be the determining factor in establishing the market share for each freight mode. In the distant future not only doubles and triples may be permitted on various segments of the nation's highway system, but also tractor-pulled trailer trains of perhaps a dozen units might ride the roads. Or perhaps we will have dedicated "truckways." Equipment productivity could be increased and in some areas TOFC-COFC service could gain a significant competitive edge.

Obviously there are a lot of serious considerations that need to be addressed before this can happen. Highway pavements and bridges would have to be adapted to these new situations. Safety considerations would dictate some type of federal regulation for minimum standards on these long tractor-trailer combinations. R&D in the areas of maximum safe multiple trailer combinations, economically optimum size and number of trailers, and proper weight-cost relationships for container systems needs to be performed.

Moreover, any such explosion of motor carrier freight must be accompanied by substantial improvements in fuel efficiency. And clearly they should not be undertaken if we are going to be running out of petroleum in a few decades. In any event they should be undertaken only with recognition that the cost of petroleum is likely to rise through market forces and may well rise further because, for reasons of revenue as well as conservation, petroleum and its derivatives are a logical target for increased taxes. Indeed they are the most logical source of any consolidated transportation funding, which would have the further benefit of tilting transportation preferences to the more energy-efficient mode.

I would also like to mention briefly the marine and air segments of our freight system. The ship and barge interests have pioneered in the area of intermodalism and containerization since the 1950's. Harbor and waterway traffic control systems have significantly increased the safety and productivity of those segments of the freight movement industry. Improvements are still needed in the terminal operations where cargoes are exchanged with other modes. More efficient dredging equipment is always a need.

As for air, although it presently handles only a small fraction of intercity cargo, it is an area that is showing considerable growth. Air freight has been growing at about 6 percent in recent years, with combination carriage showing particular strength. Moreover, a commuter air cargo, which still has a minuscule share of the air cargo market by weight, has been growing at over 30 percent annually since 1970. As demand for the speedy service offered by air continues to grow, technological improvements will become increasingly important.

In closing let me point out what the history of the freight industry suggests. Technological advances, which have been made continuously since the introduction of each mode, have provided improved levels of service and lower transportation costs – one of the basic facts on which the economic life of the 19th and 20th centuries was built.

There is not any reason to believe that the end of this process has been reached, although technological improvement in the mature freight industries is naturally slower than that which occurred during their early developmental periods.

There is not any shortage of ideas on how to improve things in the transportation field. The literature is full of potential new technologies and operational concepts, and many of these have been taken to the proof of concept or technical feasibility stage either by government programs or by private funds. Still more needs to be examined.

Operators, manufacturers, suppliers, shippers, and the government ought to get together more often to focus their collective judgment on technologies that can help to solve the problems facing us. This freight conference has assembled decision-makers who can help both to identify the desirable future trends and to initiate the steps necessary to improve the long-term viability of the nation's freight movement system. I think you are going to have an exciting session, and I wish you every success.

CONFERENCE PAPER AND PANEL

"ISSUES FACING TRANSPORTATION AND OPPORTUNITIES IMPLICIT FOR TECHNOLOGY – FROM AN ECONOMIC VIEWPOINT"

Introduction by
Charles D. Baker
Chairman
Harbridge House, Inc.

I would submit that John Meyer is, indeed, one of the leading transportation economists in the world, and one of the people who, for several decades now, has been a voice at what in times appears to be a wilderness. John is the 1907 Professor of Transportation and Logistics at the Harvard Business School. He is also the president of the National Bureau of Economics, and as I'm sure all you who are familiar with transportation are aware, has been one of the major movers and thinkers in the transportation arena for many years. During the sixties, Dr. Meyer had major inputs to a number of key transportation messages introduced by both the Kennedy and Johnson Administrations and of course in more recent years, to a number of other transportation initiatives.

John has been described by people who know him as having 360^{o} vision. That, in a nutshell, means that he's so smart that he can see every side of every problem. And, indeed, he will have something to say about this in just a minute.

. . . Following that, we are going to ask Don Johnson, director of transportation for Sears, Roebuck, and a fellow who pays a pretty good merchandise freight bill. We're also going to ask Jim Malone of Union Carbide, vice president of logistics and transportation, who also pays a significant part of the nation's freight bill, with a different set of products. Then John Secrest, vice president of American Motors, who is likewise responsible for paying a big piece of the freight bill. And next Jim Springrose from Cargill, which many of you know is probably the largest grain bulk shipper in the world. And finally, Bill Allman – you were expecting from your program Eleanor Sugrue. Eleanor Sugrue is in Washington; Bill Allman is here. They work together and, indeed, Bill is going to express the view and perspective of another person who pays occasional freight bills – the Department of Transportation.

Following this, when each of these gentlemen has an opportunity to comment upon the situation in general – and some of Dr. Meyer's remarks in particular – we're going to put this open to questions from the floor.

Dr. John R. Meyer
Professor in
Transportation, Logistics, and Distribution
Harvard University
and
President
National Bureau of Economic Research, Inc.

In addition to his more than 20 years of teaching experience at Harvard and Yale, Dr. Meyer has served on a wide range of national policy and advisory committees, including the Presidential Task Force on Railroad Productivity (1972-1973), and FEA's Energy Forecasting Advisory Committee (1973-present). Dr. Meyer has a large number of publications to his credit, many of which focus on national and regional transportation issues. He is a recipient of an honorary doctor of science degree from Lowell Technological Institute.

CONFERENCE PAPER

"ISSUES FACING TRANSPORTATION AND OPPORTUNITIES IMPLICIT FOR TECHNOLOGY – FROM AN ECONOMIC VIEWPOINT"

When first invited, I speculated as to why I was qualified to give this speech. Then it dawned on me that I had given a very similar speech before, in fact twice before – once about 13 years ago and once about 11 years ago. Recalling this, I proceeded to do a very foolish thing: I decided that to prepare for this occasion I should go back and read what I said then. This is something that I'm sure Herman Kahn and other more experienced futurists would never do! It's a humbling experience, to go back and be reminded of all those bad projections and forecasts you made years ago.

Just to give you the flavor of my qualifications as a seer, let me report to you a couple of the "better" forecasts I made back then. By far my best was that the basic sustenance of much of the railroad system – coal traffic – would disappear because of three happenings: (i) nuclear energy supplanting other forms of electric generation; (ii) increasing reliance by the electric utility industries on petroleum, which would move more efficiently by barge or through pipelines than by rail; and (iii) an increasing tendency to have electric utility generating plants at the mine mouth. I also remarked back then about the imminent prospect of deregulation and this, in turn, opening up technological possibilities and generally reducing the inhibitions on innovation.

Given my own earlier misadventures as a seer, let me start with observations that are somewhat more tangible. Specifically, let me begin by doing a bit of stock-taking of where we are today, and in particular to separate some myths from reality in today's transportation situation.

Perhaps the biggest current myth is that somehow or another all we need to do to get the railroads back on the path to real economic health is to do these things embodied in the recent Four R's Act; that is, get rid of a few branch lines and excess workers and grant a small modicum of rate-making freedom to the railroads. Now these are all very desirable reforms, certainly long overdue, and I suspect that if done 15 or 20 years ago, they might have been enough. But they are not enough now! American railroads are really in such a bad position today that something more drastic is needed. Of course, there are some notable exceptions to this rule – certain properties in good repair and prosperous. All of us know them, so I won't name them. But once you get beyond those four and possibly five systems that are in reasonably good condition, most U.S. railroads have been living off their capital in recent years.

This has been caused, in large measure, by a rate structure that has represented too much pricing at average variable cost rather than at total costs and by the fact that this rate structure has not adapted quickly to changes in costs. In short, the regulatory lag has been much too long in these inflationary times. As it has worked out, railroad right-of-way has particularly deteriorated. Much of the rolling stock is not in good condition either, but it is in better shape than ROW because financing for cars and locomotives is rather more available than for ROW.

What you have, then, is a need for a major infusion of capital into railroading. The Association of American Railroads has suggested that U.S. railroads need about three-and-a-half-billion more cash flow per year – based on prices, apparently, as of a couple of years ago. About a half of that would be needed for maintenance catch-up and new capital. One may quibble about these figures, but they seem plausible – or"in the ball park." Given these numbers, a very difficult public policy choice has to be made. If railroad system is to be restored, additional money has to come from somewhere. It can come from higher rates, but this might not be too politically attractive. Some of the need might be reduced by allowing the railroads to strip themselves down to a bare bone system, which means a substantial abandonment of service to a lot of smaller points. That combination – higher rates and substantial abandonment – would be the private sector solution. A great deal of trauma would be associated with such adjustments. The other solution would be to open up the public treasury to a substantial subsidy. That might solve the problem with a bit less trauma, at least in the short run. The public solution, though, would probably be a good deal less economically rational, especially in the long run.

From the standpoint of our discussion today, a major consequence of all this is that railroads may be effectively capacity constrained in many important parts of the system (for example, the Northeast) for many years to come. This seems strange as we all know there's all that extra track out there. Nevertheless, due to bottlenecks, the system may well be capacity constrained for at least a few years in some important segments.

A second, and rather long-standing, myth is that air freight is on the verge of a great break-through. That's something that I have heard since I first became interested in transportation economics, which, since I grew up in a railroad family, I guess was at age 12. Incidentally, that was just about the same time that the Civil Aeronautics Act was passed. Certainly, air freight has been doing well. It has been growing rapidly and steadily. But it isn't all that significant in absolute terms because you're starting from a small base. Air freight should continue to develop in basically healthy ways – systematically, sensibly, and in new markets for the most part. From time to time air freight will also nibble at the surface markets for very high-valued goods going on long hauls or express-type operations, but it will not impact the surface modes too significantly or abruptly. Higher energy costs, and the fact that the wheel's not all that bad an invention, further reinforces this conclusion.

That brings me to the third myth. This is the view that recent factor price changes, and particularly the run-up in energy prices, will drastically – not moderately but drastically – restructure intercity freight cost relationships. This will not happen, quite simply, because energy is not all that significant a cost component, except possibly for air freight. Even there, the impact on air freight will be delayed for some while until all those empty cargo holds of the wide-bodied planes are filled. In addition, if you have a sudden ratcheting upward in one price, other prices after a while will more or less catch up. After all, it does take energy to produce other goods, too. Furthermore, wages will move to restore real purchasing power. So, there will be a balancing or a tendency to restore previous factor price relationships. Finally, the intercity freight mode most advantaged by a relative run-up in energy costs is the railroad, and rail's exploitation of its advantage will be inhibited by those capacity constraints mentioned earlier.

It is also useful, before attempting any forecasts of the future, to try to identify the basic trends at work, and recent developments of particular significance. One trend of particular importance is that in an economy such as ours the service sector and specialized high-quality goods play an increasingly large role. Freight tonnage, accordingly, just simply does not expand proportionately with GNP. This reduced physical demand normally translates into lesser revenue growth as well. The ratio of freight revenue percentage increases to GNP growth is just slightly below unity as a rule. Thus, if you say a growth industry is one that expands more rapidly than GNP, intercity freight does not meet the test. In physical or tonnage terms, intercity freight has been expanding even more slowly, at roughly two thirds the rate of GNP. This differential between physical and revenue growth rates obviously reflects a trend toward use of more sophisticated transport services.

A very recent event of potential importance to the future of intercity freight is the nationalistic or foreign policy incentive to substitute coal and nuclear energy for oil wherever possible. Quite clearly, these two substitutions will have very different impacts on the intercity freight system. Substituting coal for petroleum obviously will increase total freight demands; substituting nuclear energy will do the reverse, especially after any attendant construction boom is over.

A second major recent development of very substantial significance is the increasing dependence of the world on American farm exports, particularly grain exports. This is not, incidentally, just a one-shot occurrence due to crop failures in certain parts of the world. It represents, rather, basic trends in diet and the use of more meat, and so forth.

What do all these cross-currents and developments suggest about the future? First, through the 80's at least, the railroads will find it to their comparative advantage, given their capacity and other limitations, to specialize heavily in what they have always done best: bulk movement, particularly of dry cargo, and to a lesser extent, specialized high-volume movements of certain higher value goods such as automobiles. These activities, doing what they can do in that little niche of high-value manufactured goods which still remains with the railroads, and in coping with the demands of increasing export grain and coal movement, could readily utilize much of the available rail capacity. This would, I think, be particularly true in the Northeast and the granger states, where the deterioration of the rail system has been rather more extensive than elsewhere. Of course, it is also quite obvious that more nuclear generators could eventually undermine some of the coal traffic, but this is going to take time as we all know, for environmental, economic, and technological reasons. Mine-mouth production of electricity will also happen, especially as the electricity grid fills out. But this will also take time. Thus my earlier predictions may not have been all that incorrect, but perhaps just a bit premature. Coal's demise, if it happens, won't happen overnight. By contrast, it's difficult to envisage any threat to the grain traffic, at least for the foreseeable future.

The main technological or managerial adaptation that emerges from this for the railroads should be a stress on the unit train or multiple carload shipment. The unit train and multiple carload shipment should be to the late 1970's and early 80's what containerization and intermodalism were to the 60's and early 70's. Similar concepts could well occur on the highways as well, as John Barnum suggested, in the form of multiple trailer truck lash-ups. I might add that the unit train concept should also be extended by the railroads using more trailer trains for moving manufactured goods. Anything to get trains out of yards is a step forward!

A couple of negative projections emerge from this, too. First, the days of the boxcar seem numbered. Of course, the boxcar will not disappear overnight. But it will be phased down, as has already occurred to some extent. Another negative implication is that sophisticated electronic switching and classification yards should have a lesser relative role to play in future railroading. If I were in railroad management, I would scrutinize carefully new proposals for such installations.

What it really means, I guess, is that American railroads are far more likely to go the route of the long, slow train rather than that of the short, fast one. The only development that might change that projection would be the injection of very, very substantial amounts of government money into the development of railroad right-of-way that would sustain higher speeds. I find it hard to believe that we, as a society would be quite that foolish. But one can never be sure!

The other intercity freight modes will be little impacted by these developments. They will continue to develop along the lines that they now are, with particular stress on completion of what I would call the containerization and intermodal revolution. Some small adaptations may occur, though. The independent truckload truckers may be slightly impacted by railroad trailer trains and by a slight energy advantage for railroads. Again, railroad capacity constraints, service problems, and other difficulties will limit this development. The specialized, less-than-truckload common-carrier truckers may be slightly impacted by air freight, especially on long hauls of very high-valued goods. But that trend will be very minor in terms of the overall situation of the common carrier truckers. In general, truckers should continue to do well, possibly even slightly enlarging their market share, especially if they can pursue some of those technological developments John Barnum mentioned.

I do not, by the way, anticipate any big breakthroughs by barges or pipelines, in spite of the fact that I have long been fascinated by the slurry pipeline idea. Stenason, Zwick, Peck, and I were perhaps among the first to talk about these possibilities in print. I have been impressed, though, over the years that what slurry pipeline proposals really do is put pressure on the railroads to more fully take advantage of their inherent advantages in dry bulk commodities, mainly by developing the unit train concept.

How would I summarize all this? Perhaps in one phrase: The future will largely be more of the same. The reasoning is simple: The railroads are too enfeebled to modify the status quo very much and the other modes are too satisfied or doing too well to bother changing things much. The only development that might modify this forecast seriously would be some breakthrough in railroad labor relations so that manning requirements were rationalized. This could bring quicker, smaller trains into play that really competed with trucks.

The only other strange noise in the night that one might foresee upsetting the status quo would be the air cargo industry tiptoeing up on certain specialized segments of the trucking industry.

All this may not be too exciting, but it also shouldn't be too embarrassing if I were again foolish enough to come back to my forecasts 10 years hence. And that seems to be ambition enough for now!

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Question: Are there not better possibilities for energy savings with a regulated motor carrier industry than with a deregulated industry — such as, assuming government takes positive action to incite increased utilization of capacity?

Answer: I suppose it is at least possible to regulate the motor carrier industry so as to do a better job in conserving energy than would be achieved by a deregulated competitive industry. However, the whole history of regulation argues to the contrary. Economic theory, moreover, tells us that competition generally creates incentives, otherwise lacking, for cost economies, including energy conservation.

Question: What are capacity constraints in railroad industry that you mention? If in line capacity, where? If in some other area, please identify. Also, against what forecast of traffic do you make this judgment? (My own analysis is that the railroad industry can at relatively minor cost provide the capacity that is needed to handle the growth in traffic predicted by even the most optimistic forecasts. The railroad problem is not preparing to handle more traffic — it is that we have too little traffic.)

Answer: What I said was that "for at least a few years railroads will be effectively capacity constrained even if otherwise unleashed to compete." By this I meant to indicate that very sharp percentage increases seem unlikely in the total volume of traffic to be carried by railroads as a consequence of deregulation, or of any other abrupt changes in public policy. I do know, moreover, that Conrail (accounting for, I believe, roughly 13 percent or so of total U.S. rail traffic) would find it very difficult to expand total volume much over the next two years or so. Expansion is constrained by lack of locomotion, the poor quality of the roadbed, undermaintained rolling stock, and so forth. Furthermore, rehabilitation of the roadbed and rolling stock are both, in turn, inhibited by shortages of necessary equipment and sometimes personnel as well. I would be rather surprised if somewhat similar remarks did not apply to other roads in or near bankruptcy in other parts of the country.

Any capacity constraint is also sensitive to diurnal and seasonal surges in traffic so that one might expect any constraints to be more operative at certain specific time periods, as, for example, when large volumes of grain are moving for export. On the other hand, though, I also recognize that there are several well-maintained properties which could unquestionably handle some increase in traffic on relatively short notice. It must be remembered, moreover, that very few segments of the rail system live in isolation from other segments. Thus, while it is not quite true that the rail system is like a chain, no stronger than its weakest link, there is nevertheless at least some truth in that old saying when applied to the rail network.

Question: Do you believe that substantial increases in the legalization of truck size and weight allowances (including, say, single axle weight limits of 26,000 pounds and 120,000 pounds gross weight limits) would have a significant impact on diverting commodities from the railroads? If your answer is only for some commodities, then please identify the types of commodities that you think would be diverted.

Answer: A very good question, but one which would require a great deal of detailed analysis to answer with any reasonable precision.

Question: Most transportation discussion centers upon common carriage. However, there is no doubt that private transportation is a real threat to this concept of transport. What is your opinion concerning the magnitude of this threat and, specifically, how will the rail mode be affected? Assuming you concur that common carriage is threatened, what remedial actions to you recom-

Question: (Cont'd) mend to avert this trend? Due to the fact that utilization of railroad rolling stock is so low, do you foresee, as some others have, that eventually the shipper will bear the burden of rolling stock ownership, and the rail company would own just the roadway and motive power? This would, in theory, create an incentive for the shipper to increase utilization since his capital is tied up, not the railroads'.

Answer: There are really several questions imbedded in your inquiry. Personally, I would feel that the best way of averting any trend toward private carriage would be to reduce the regulations placed upon common carriers so that they can compete more effectively with private carriers. To a considerable extent private carriers are a creation of the regulatory process. With regard to low utilization of rolling stock, I would hope that we could find better solutions than having shippers increasingly involved in ownership of their own rail cars, though I would not rule this out as at least a partial solution to some of the low utilization problem. Among the other possibilities were some I mentioned in my talk – increased use of unit trains and trailer trains. More advanced computer monitoring of freight cars should also help; hourly per diems in lieu of daily charges (as just recently proposed and analyzed by an M.I.T. research group) could also contribute.

Question: I am curious about the current level of horizontal and vertical integration that exists in the rail industry. Currently the telephone system has been under attack for excessive integration. Are there any arguments today for increasing or decreasing integration and in what sectors of the industry?

Answer: I do not find arguments for increasing or decreasing integration across modes in the transport industry very compelling one way or the other. I suppose on balance I would guess that some removal of constraints on such integration would be slightly helpful, but I would not belabor the point or expect any such change in policy to work wonders. As for intramodal mergers, I favor end-to-end over parallel mergers, mainly on grounds of improving service and, hopefully, better aligning available managerial talent and financial capability.

Question: You emphasized that petroleum fuel costs would not be a major impact, but what will be the magnitude of limitations on availability of petroleum?

Answer: What I said was that while I felt that energy was a terribly important consideration, given our topic, I also was willing to bet that if we were to reconvene this conference 10 years hence that we might well conclude that we had been too concerned or preoccupied with energy problems. One of the many considerations in my mind when I made that remark was the simple arithmetic that intercity freight transportation does not account for an overwhelming portion of total petroleum consumption, let alone total energy consumption, in the U.S. today. If my memory serves me correctly, I believe intercity freight accounts for less than 10 percent of total petroleum consumption. Furthermore, a good case can be made that except for some aberations created by regulation, energy is reasonably efficiently used by the major modes of intercity freight transportation. Accordingly, I would expect that if we once again faced a severe reduction in petroleum availability that the impact would and should be felt in other sectors which account for a larger percentage of total petroleum consumption and which probably makes less efficient use of such petroleum, such as space heating and automobiles.

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Subsequent Remarks by Dr. Meyer (In Response to Panel Remarks)

One difficulty is obvious, and I think it's as much my fault or of the format as of any discussant. This is that when you do a very broad-brushed introduction to these complex subjects, it's easy to be misunderstood.

First of all, I didn't say that the coal market wouldn't expand. I made that mistake several years ago, and I wasn't about to repeat it. What I did say was that there is at least a possibility that the transportation market in coal may not expand forever because you could have mine-mouth and nuclear developments over time. Coal, therefore, was probably not quite as dependable or inexorable a source of growth to the railroads as agricultural products were, particularly grain.

I also didn't say that the railroads would survive on grain alone, though some parts of the railroad network probably could. What I said, rather, is that grain and related agricultural products were the most dependable source of growth one could see in the future for the railroad system.

I also didn't say that unit trains are everywhere applicable. I was very careful to couple unit trains with a tendency toward multiple carload shipments and rates. A flexible response is needed. I was trying to underscore the basic trend, but I guess my broad brush was perhaps too broad.

I also didn't say that bargelines wouldn't expand. I just said that they were in the wrong end of the business to achieve rapid expansion in the future. What they have done is to capture about as much of the market share for bulk commodities as they are likely to from their major competitors, the railroads in this case. Barge growth in the future thus would be geared more to the growth of GNP and, unless something drastic happens, bulk business doesn't expand quite as quickly as GNP. So barges will grow, but not all that rapidly.

I also certainly didn't suggest that we shouldn't come to grips with the policy issues as quickly as possible. In the pattern of a previous president, perhaps I should pull my shirt up and show you my scars from asking people to worry about these problems in years gone by. Early warning does help, and we certainly should do our best. Perhaps, though, because of being through these debates so many times, I am a bit cynical about the effectiveness of early warning. I'll keep trying, though. Otherwise, I wouldn't be here this morning.

A real issue, though, where there's possibly some disagreement between myself and the other panelists is on energy effects. The other panelists apparently believe energy shortages and price increases will have more impact than I do. I said that energy would have a moderate impact but not a substantial or overwhelming one. There are simply too many rigidities in the present system for it to be otherwise. Because of the energy problem, the railroads can't or won't recapture overnight a lot of business from the truckers. By the time that the railroads might be in condition to do something like that, technological changes (such as Mr. Secrest in particular talked about) will occur that will allow the trucks to conserve on energy, even in the face of environmental controls. Some of the possibilities that John Barnum mentioned will also occur – for example, heavier and longer loads, especially on high-performance interstates. I might add, too, that the trade-off between fuel efficiency and cleaner air can be, I think, overstressed. Of course, if we continue as we have been, not giving clear-cut signals, about which Mr. Secrest properly complained, we can do some very foolish things. A very simple adaptation, for example, stabilizing the NOX standard at about a 1.0 or 1.1 g.p.m. rather than at .4 as is now the target, would do much to eliminate the trade-off between fuel efficiency and cleaner air.

So let me be very provocative and assert that if we were to come back and review this conference 10 years hence, I would suggest that we might conclude that we were a bit too concerned about the energy aspects. These are important, but can easily be overdone. Let me also stress again that the energy impact depends on relative factor prices, and as fuel goes up other prices will go up, too. The impact of a sudden ratcheting up of a few prices does have a way of dampening down through the market system as time goes on.

One final comment on the full modal or total transportation company: It's a heck of a good idea and I think it's long overdue but I would make a couple of observations. First, the concept has been in existence north of our border for some time and it's helped, but it hasn't solved all Canadian transport problems. Second, there once was in the United States a total or full modal transportation company that had full operating rights for truck, water, and even air as well as rail in its area. The name of that company was the New York, New Haven, and Hartford.

DISCUSSION PANEL

"ISSUES FACING TRANSPORTATION AND OPPORTUNITIES IMPLICIT FOR TECHNOLOGY – FROM AN ECONOMIC VIEWPOINT"

Remarks by
Donald C. Johnson
National Manager of Transportation
Sears, Roebuck and Company

Energy

The single most critical issue facing intercity freight transportation over the next two decades will undoubtedly be energy – its cost and its availability. Most experts in the field anticipate that we will have severe problems by the 1980's with shortages of petroleum products. Other things being equal, fuel shortages will obviously result in less energy-sensitive modes of transportation being utilized – greater consideration of rail and water and turning away from air and highway motor vehicles.

"Other things" will probably not stay equal, however. Any such trend will undoubtedly be greatly influenced (and perhaps even reversed) by fuel-saving developments in engineering technology. Further, it could well be that severe shortages or drastic cost increases in petroleum fuels could force changes in the government's environmental policies. For example, I understand that it takes approximately 13 percent to 18 percent more crude oil to produce no-lead gasoline than it does to produce leaded gasoline.

Regardless of what the oil-producing nations decide to do over the next few years, it seems crystal clear that our national energy policy must include an acceleration in technological research and a reassessment of environmental policies as they impact on fuel needs for intercity freight transportation. For some reason it appears that transportation considerations are usually either neglected or taken for granted by deliberations in other sectors of our national life unless we arrive at the brink of a national crisis such as a countrywide shutdown of our motor carriers or the financial disintegration of a large portion of our railroad system.

Regulation

Regulatory policies will also have a major effect on future transportation. As a nation, we have committed a massive amount of capital to the development of a transportation system that supplies the underpinning for the most productive economy in the world. Yet the transportation system itself operates at far, far less than peak efficiency.

Regulatory reform aimed at improvements in efficiency could have great effect on future growth patterns among the various modes of transportation. When studies made for the American Association of Railroads indicate that freight cars are only in line haul movement some 16 percent of the time and a good part of that empty, surely we need to find ways to use this tremendous capacity and investment more productively. When motor carriers (whether common, contract, or private) are forced to move long distances empty or lightly loaded because of restrictions on what, where, and over which route they may transport shipments, surely we need to find ways to utilize motor carrier equipment and the country's highway system more efficiently. When very costly, high fuel consumption jet aircraft consistently fly around the country and the world half empty, surely we need to find ways to be less wasteful of this marvelous technological achievement.

Again, for some reason that is hard to understand, we have allowed ourselves as a nation to move forward exceedingly slowly with needed reform in the economic regulatory area of transportation.

Physical Distribution and Air Transportation

For years – ever since "jumbo jets" appeared on the drawing boards of the aircraft manufacturers as genuine commercial realities – most of us have been hearing about and talking about the coming "air freight revolution." Unless you are distributing a very perishable commodity or one with an extremely high value per pound, most of us are still waiting for the revolution and air freight still represents only a very small percentage of intercity freight transportation.

I, for one, still believe such a revolution can and will occur providing the appropriate applications of existing technology come to pass and assuming that the energy problem is reasonably solved. In any case, the "air freight revolution" necessarily depends on aircraft design that is more cost effective in the movement of freight than present equipment. The technology obviously has to be in fuselage design for greater utilization of cube, greater lift capacity, and less sophisticated for cargo than needed for passenger travel. For

Since joining the Sears organization in 1953, Mr. Johnson has held a number of key positions. Before assuming his present position, he was director of distribution services and director of distribution systems management.

example, near-sonic speeds and pressurized cabins would not be needed for much cargo movement.

The technology for such design certainly exists now. As the cost of constructing and operating warehouses in populated areas continues to rise steeply and the financial costs of maintaining numerous scattered inventories stays at a high level, the potential ultimate "payoff" of "relatively" low-cost air transportation should become more and more attractive.

Paper-Handling

A torrential flow of paper is perhaps one of the major "hallmarks" of the transportation industry. From proposals to tariffs to bills of lading to revenue bills to regulatory briefs and beyond, much needs to be done to abbreviate, simplify, standardize, and mechanize paper-handlings and clerical work in transportation.

This problem has been recognized for years and many people are striving valiantly to find some solutions. Progress, however, is agonizingly slow. Some "breakthrough" – technological or not – is sorely needed.

Perspective

Perhaps what is needed most of all to bring into focus the long-range technological needs and opportunities related to intercity freight transportation is a better perspective. Individual groups seem to get caught up in individual causes and there are no panaceas for these complex issues. Ecology and economics must be balanced. Regulatory protection must be weighed against competitive efficiency. Institutional resistance to change must be overcome by recognition of the fact that change already threatens to engulf us.

If I could succeed in leaving just one point with you, it would be this: By addressing ourselves to the 1980's and 1990's, we may easily be lulled into complacency about hazy, futuristic problems. Speaking from the practical standpoint of a major shipper in the real world, I respectfully call to your attention that we must begin to come to grips with the issues I mentioned NOW. If they are permitted to grow into the 80's and 90's unsolved and uncontrolled, transportation may not be able to cope or provide the support to our national life as we have depended upon it to do in the past.

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Question: You said, "Every penny fuel cost equals $1 million to Sears." Most of us can't relate to this because we're not conscious of Sears's total figures. To relate it more understandably, How much increase in Sears prices results from a 1 percent increase in oil price? Also, what proportion of Sears prices is in transport cost? (Submitted by Herbert E. Bixler.)

Answer: For the fiscal year ending January 31, 1976, Sears had net sales of $13,640,000,000 and Net Income after taxes of $523,000,000. Sears's selling prices are not directly "tied to" fuel prices. Much of any increase in fuel cost would be reflected in the expense of operating trucks to deliver merchandise to customers' homes and vehicles to provide mechanical repair service to appliance-type products in customers' homes. These costs are treated as general operating expenses and are considered only indirectly in our selling prices along with increases in our other operating expenses such as wages, rent, and so forth.

Transportation cost on purchases is reflected in our selling prices somewhat more directly in that adjustments may be made when freight rates are increased if competitive pricing permits. The proportion of transport cost to Sears's selling price varies greatly among the different kinds of merchandise we sell. It is insignificant on fashion apparel, but substantial on steel fencing. As a matter of policy, actual figures are considered to be proprietary and confidential information.

Question: As one of the largest shippers, would you support the adoption of a "standardized intermodal through bill of lading," which would replace the various waybills, freightbills, and so forth, currently existing? What problems, both technical and political, do you foresee before a document of this type would be accepted by shippers, carriers, and government agencies? (Submitted by Robert Torene, Transportation Branch, U.S. Census Bureau.)

Answer: We, of course, would like to see the transportation industry achieve a great deal of simplification and standardization in its paper-handling, including a "standardized intermodal through bill of lading." Since I assume that the question refers to international shipments, we are interested in the rate, route, and claim implications of such a through bill rather than obtaining a single "wallpaper" document. The present bill used for mini-land bridge shipments is a current example of an intermodal through bill.

The obstacles to widespread implementation are great, however. Different regulatory agencies are involved whose different standards and procedures must be resolved. Different nations are involved whose different legal systems and customs must be resolved by treaty, and so forth.

DISCUSSION PANEL

"ISSUES FACING TRANSPORTATION AND OPPORTUNITIES IMPLICIT FOR TECHNOLOGY – FROM AN ECONOMIC VIEWPOINT"

Remarks by
James C. Malone
Vice President
Union Carbide Corporation

Union Carbide utilizes all forms and modes of transportation service – pipeline, rail, water, highway, and air – to supply raw materials and fuels to our more than 100 major manufacturing facilities in the United States and Puerto Rico and to distribute finished products from plants, warehouses, and distribution centers to the American public. In 1975 Union Carbide grossed $5.7 billion from the sale of chemicals, plastics, gases, metals, carbon products, batteries, home and automotive, and consumer products. Raw materials for such products include manganese and chrome ores for the production of ferroalloys; liquefied petroleum gas and naphtha for the production of ethylene and its derivatives such as polyethylene and ethylene glycol; petroleum coke for the manufacture of graphite products; and so forth. Presently our U.S. and Puerto Rican business accounts for approximately two-thirds of our sales with the other one-third being international.

Our transportation bill in 1975 exceeded $175 million for U.S. and Puerto Rican business and another $150 million was spent on distribution terminals, warehouses, tank cars, hopper cars, private trucking, barges, packaging, and packaging facilities. Union Carbide's reliance on the U.S. freight system to support our continued growth is evident. As we prepare our plans and establish goals for the 1980's and 1990's, the ability of the transportation community to support these plans and goals is vital to their very realization.

A few years ago one of our planning managers conducted a study on the state of transportation technology. In the process he tracked the rate of growth in technological advances over a 20-year period. Technological advance was defined as improvements in processes and equipment which resulted in increased productivity. The study indicated that the rate of growth in transport technological advances was slowing down and may even have topped out. His conclusion then was that the pace of transport technology depended on the quality of national transport leadership, in the definition of national objectives, and the development of logical coordinated programs to meet the demands of the decades ahead.

In addressing the question of issues and challenges to transportation technology, some major considerations need to be given to the health of the transportation industry and the economic, regulatory, and institutional climate in which it presently operates. The railroad industry occupies a large part of the thinking in this area. Union Carbide actively supported the Railroad Revitalization and Regulatory Reform Act of 1975 and also supported subsequent legislation, the Railway Transportation Improvement Act of 1976. Our interest in both pieces of legislation stems from the conviction that financial assistance in the form of guaranteed loans is necessary if the railroads are to rehabilitate their present plant and satisfy current demands for service. While there is concern in some quarters that ConRail is the first step toward nationalization, there were no viable alternatives and, if its first six months are any indication, we believe that ConRail can ultimately be self-supporting and free of government affiliation. The railroad industry is a critical factor in plans to accommodate the growing shift from petroleum to coal as a source of energy. The railroads also continue to be the third most efficient form of transportation in cargo ton-miles transported per Btu consumed. Pipeline and water transportation are the first and second most efficient, but are subject to obvious constraints with respect to their usage. Transportation, including the automobile, accounts for about 20 percent of our energy usage.

With reference to energy, current estimates are that the U.S. requirements will increase from 33 million barrels per day of crude oil equivalent in 1975 to 60 million barrels per day of crude oil equivalent in the year 2000. Coals is expected to account for 38 percent of the net gain in supply. Coal development and growth for the balance of the century can be limited by a number of economic considerations and one of the primary considerations is the ability of the world and national transportation systems to move massive new quantities of coal longer distances from both old and new reserves. To achieve these goals and to maintain the American standard of living the total transportation resources of the nation will be taxed to capacity.

When the enormity of the task before us is realized, there is no question that every mode and form of transportation is needed. The bickering today in the transportation industry over user charges for waterways, user charges for highways, increased maximum gross weights on highways, regulation or deregulation of transportation or

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Mr. Malone, director of the Transportation Association of America, is responsible for Union Carbide's Energy, Supply, and Services Group. He received the Belgian decoration of the Order of the Crown in 1971 for his work in furthering economic ties between the U.S. and Belgium.

liberalization streamlining of the regulatory processes, replacement of the locks and dams on the inland waterways, eminent domain for coal slurry pipelines, hopefully represents an awareness of the forthcoming opportunities both in the increased volumes of present business lines and the creation of new business lines for transportation services. This competition for transport business has served as a catalyst in the past to spur development of technological advances. It should not now serve as a deterrent to the growth of the transport industry. The inherent advantages of each mode need to be optimized and optimization through combinations of modes encouraged. For example, early next year Union Carbide will marry two of its more efficient modes, barge and rail, to bring our polyethylene resins from Gulf Coast plants to the East Coast plants and terminals. We will load our resins in bulk containers on barges at Texas City, Texas, and bring them by water to Leetsdale, Pennsylvania, where they will be transloaded to container rail cars for movement by ConRail to Bound Brook and Perth Amboy, New Jersey.

Union Carbide, like other American companies, is putting together today its plans for tomorrow. To make these plans realistic we need to be able to make reasonably accurate assumptions about the state of transport technology five years, 10 years, and even 20 years from now. The magnitude of our investment in distribution facilities, equipment, and transportation makes significant demands on our budget dollars and the capital to meet those demands needs to be anticipated as early in the game plan as possible.

On the chrome and manganese ores moving by barge from Burnside, Louisiana, to Marietta, Ohio, and Alloy, West Virginia, today, is it safe to plan on using larger barges and reduce our turnaround time by two, four, or six days? To transport coal from the Western Reserves to Texas City, is it reasonable to expect to move it in unit trains with self-unloading cars at average speeds of 60 mph? Will the railroads have progressed automation of their yards sufficiently to allow through-train service of unit trains of chemicals and plastics? What will constitute a unit train: 25 cars, 50 cars, 75, or even 100? What will the conversion of diesel locomotives to coal cost the railroads and what effect will the new (?) fuel (coal) have on the pulling capacity of the locomotives? How can the motor carrier industry survive in the face of pyramiding increases in fuel costs and dwindling supplies? Is hydrogen a realistic alternative? Will the major population centers be served by conventional transportation of today or should we plan on repackaging Prestone, Eveready batteries, Glad Bags, and Glad Wrap to accommodate a monorail or an intracity automated conveyor belt?

If we can follow our barges along the waterways today and monitor the movement of hopper cars and tank cars all over the country through the wizardry of the computer, can we go one step further and follow our truck shipments by having the motor carriers' computers communicate with our computers? Can we hopefully lay to rest some of the death-defying paperwork that surrounds every transportation transaction through the advances of computer technology? If the banks can talk about a cash-less, check-less society of the 1980's, can transportation be too far behind with the elimination of the paper bill of lading and the paper freight bill? When we select sites for new plants, will the transportation pricing system be sufficiently modernized so that we can guarantee or be reasonably certain of the long-term costs of delivering our raw materials and finished products? Will transportation safety dictate the construction of separate rail lines with no grade crossings and truck-only highways to distribute hazardous materials? What specifications are needed in the design of equipment, roadbed, and highway to maximize the conservation of our natural resources? Finally, what kind of inventory policy for raw materials and finished product will the transportation industry of the year 2000 support?

Earlier we mentioned the capital requirements of Union Carbide to transport its raw materials and distribute its finished product. Obviously, some of the potential developments discussed here will require huge investments by the carriers and the government. Union Carbide has a history of working closely with both in bringing us this far. We expect to continue that policy in the future.

* * * * *

Question: What about improvements in safety, especially in transportation of hazardous materials?

Answer: Union Carbide is aware of its responsibility for safe transportation of hazardous materials. This awareness is reflected both in the number of people and resources expended throughout the corporation to assure that current practices provide maximum protection. Some of these current activities at Union Carbide include educational seminars at all levels; inspections and audits of safety practices at our shipping and receiving facilities by both company personnel and outside agencies; inspection of railroad yards, tracks, and equipment by joint teams of railroad and company personnel; safety meetings with motor carriers; and conversion of our barge fleet from single-skin to a safer double-skin design. Union Carbide was instrumental in the formation of the Hazardous Materials Advisory Council, an association of carriers, shippers, and governmental groups whose goal is to promote safety in transportation of hazardous materials.

Answer: (Cont'd)

If, in spite of every precaution, a transportation incident occurs which involves hazardous materials, Union Carbide's internal program, HELP, is a 24-hour, seven-day system that provides fast telephonic advice and expert manpower. We are also members of Manufacturing Chemists Association program, CHEMTREC, which provides an identical service on an interchangeable arrangement for all of its members. Both programs are organized to minimize injury or exposure that may result from any such incident.

For the future, Union Carbide works with the manufacturers of rail, truck. and water equipment; governmental agencies; and the carriers as well as trade associations such as the Manufacturing Chemists Association and Compressed Gas Association on design developments which will maximize safety features. I mentioned in Boston that we are currently using computers to follow railroad cars of hazardous materials and these same computers are going to provide data on possible re-routing of hazardous materials around high-density population areas. Distribution studies now under way are evaluating the relative levels of safety provided by each mode for any given product or group of products.

Question: Would you (UCC) support the adoption of a "standardized intermodal through bill of lading" which would replace the various waybills, freight bills, and so forth, currently existing? What problems, both technical and political, do you foresee before a document of this type can be accepted by shippers, carriers, and government agencies?

DISCUSSION PANEL

"ISSUES FACING TRANSPORTATION AND OPPORTUNITIES IMPLICIT FOR TECHNOLOGY – FROM AN ECONOMIC VIEWPOINT"

Remarks by
John C. Secrest
Group Vice President
American Motors Corporation

I am going to speak to you today from the perspective of a non-transportation expert. Jim Malone's only been exposed to transportation for the last year and a half. I've been exposed to it mostly over the Thanksgiving holidays [laughter]. I've done a lot of reading, and I think I've done more thinking and reading about domestic freight transportation in those five days than I have in the last five years. But I found it quite interesting, and I would like to share some of these ideas.

I would like to concentrate on truck and rail, which are the principal segments that we use for transportation in the automobile industry. I also speak from the standpoint of the only auto company that does not make heavy trucks. Thus, I have no vested interest, so I can be quite objective.

I talked to our traffic people about what developments presently or in the future are of greatest interest to them and of greatest concern. I have to tell you that they're delighted with the completely enclosed rail cars, or even the side-shielded railroad cars. What it has done for them just overwhelms everything else, and they're almost satisfied with this alone. Some of the test runs we have made indicate we've reduced damage on the outbound vehicles we are shipping by a factor of nine to 10 times with these completely enclosed rail cars. This obviously enables you to deliver the products in better shape to the customers, and saves substantial costs to the railroads, and ourselves. We're only 20 percent into enclosed cars now, and we'd be delighted if we could be 100 percent into it in the next two or three years. We are pushing that way, as rapidly as possible. I kept pressing them for what developments are of greatest interest to them, but they primarily reverted to this one development as far as the railroads are concerned. However, particularly on the inbound rail shipment of components – and the outbound rail shipment of finished autos as well – to the extent the railroad cars can become more timely in their deliveries, the auto industry can certainly make increasing use of railroad cars because they are more effective from a ton-mile standpoint.

I think that we're well served by the truck industry, and they are not aware of important developments outside of the possibilities for longer and wider trucks to reduce costs.

Now, I would like to also make some generalized observations which relate to some of the experiences we've had in the passenger car business, which does occupy 99 percent of my time. These particularly relate to the remarks by Secretary Barnum on fuel conservation, and to one of the earlier remarks by Professor Meyer on the need for capital. I'd like to concentrate on these two issues.

The domestic freight transportation industry is composed of complex, highly interrelated segments, strongly regulated by governmental agencies. The industry is capital intensive, but not characterized by a high return on capital in many areas. Changes in technology are not rapid, and require considerable capital and long lead times to execute. Thus, when dramatic external changes occur, it's difficult to realign to the new realities. Many such external changes have occurred in the past decade, particularly in the last three to four years. These include an energy crisis, a pervasive high level of inflation, a growing capital shortage, and an increasing concern with such environmental factors as air pollution, water purity, and noise problems. Intensified consciousness of safety considerations and chronic high unemployment is also affecting some of these areas.

The structural inflexibility of the railroad and trucking industries in responding to these changes in external factors is compounded by many regulatory restraints. But at least many of these restraints in our view are necessary – for example, the necessity for rate regulation in areas that are geographically isolated, where little or inadequate competition exists. There certainly has to be a need for some form of regulatory structure. If the domestic freight transportation industry is to respond effectively to these many external changes, it seems to us that some hard choices have to be made, and priorities of action established.

First on our list of priority action would be the conservation of energy. Some short-term measures can be taken relatively quickly, through appropriate modifications, for instance, on back-haul restrictions on trucks. There are numerous medium-term steps that can be taken in truck design such as more streamlining, and more liberal and more uniform state regulations on length and width. Even freight consolidation terminals outside the major cities certainly offer promising possibilities, although I can't help but consider the analogy

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Since joining American Motors in 1961 as vice president of purchasing, Mr. Secrest has held positions within the corporation as vice president and general manager of the Appliance Division, vice president of finance, and vice president of corporate staffs.

in the auto industry where the idea was to make larger and larger assembly plants, until many of us finally concluded that there was a limit to the practical size of assembly plants, which we think is about 60 units per hour. Likewise, I think that perhaps in freight consolidation points outside metropolitan areas, if they get too large and complex they may lose the timeliness of service that shippers are looking for.

Concerning the development of more fuel-efficient truck engines – whether they are multi-fuel diesel, sterling, or turbine engines – if these should ultimately prove more fuel efficient, they will be long-term projects at best. The auto industry has about $8 to $10 billion wrapped up in engine manufacturing equipment; so between the time necessary to develop the ideas and prove them out, then convert the facilities, it's hard to see how you'll have radical changes in the power plants of trucks before the 1990's.

Railroads can make a major contribution toward fuel conservation by several steps: better maintenance of their tracks, certainly; streamlining of freight car designs; common ownership of rail cars; and other measures. All of these could conserve fuel, and perhaps even more importantly, shift service back to the railroads that they have lost because of lack of adequate service. But, for many of these actions, capital requirements are intensive, and many of the railroads just don't have that capital.

If important progress is to be made in fuel efficiency, there must be national priorities established toward that objective. For example, the passenger car industry in this country has been hamstrung and confused by the inability of Congress to determine which has the higher priority: fuel efficiency, or the quest for cleaner air. There are still various factions in Congress that are pulling in opposite directions, and we don't even have 1978 air pollution standards settled at this point of time.

In these brief remarks, I focused on a single factor of the many conflicting demands for priority consideration – energy conservation – because I feel as some of the earlier speakers have, that there will be constantly pyramiding prices from the OPEC countries, and these will accelerate as the worldwide supplies diminish over the next 20 years. In focusing on fuel conservation, however, it quickly becomes apparent that related capital requirements are extremely heavy relative to the ability of many of the competing companies in the transportation industry to take actions that are necessary to conserve fuel. So in establishing our national priorities as they affect domestic freight transportation, measures designed to provide capital on some basis – whether it's through relaxation of some of the rate structures that would enable the generation of profits, or other measures – certainly should be high on our list. And while I put this priority on fuel conservation and the related capital requirements, in no way should I discount, or do I want to discount, the importance of other factors such as noise reduction or emission control improvement. But, as in the auto industry, I think it does mean that there will have to be some compromises necessary, and I'll cast my own personal vote for giving fuel conservation the highest priority.

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Question: Would you support the adoption of a "standardized intermodal through bill of lading," which would replace the various waybills, freightbills, and so forth, currently existing? What problems both technical and political do you foresee before a document of this type would be accepted by shippers, carriers, and government agencies?

Answer: The bill of lading document is a contract for carriage. Any suggestions for "standardization" that would or could reduce other documents required in the conduct of business certainly would be welcomed by industry and carriers alike. We don't see any technical problems from the shippers' standpoint. Reference to the political problems is not understood, unless you may be referring to import and export business where government agencies both foreign and domestic would have a great deal of input.

DISCUSSION PANEL

"ISSUES FACING TRANSPORTATION AND OPPORTUNITIES IMPLICIT FOR TECHNOLOGY – FROM AN ECONOMIC VIEWPOINT"

Remarks by
James Springrose
Vice President
Cargill, Inc.

I would like to comment for just a few moments on what John Barnum and John Meyer alluded to, particularly with respect to agriculture and its impact on technological advance, its impact on railroad futures. I guess to some extent, at least with respect to grain, I cannot agree that railroads could survive simply by transferring their major emphasis over to unit train movements of dry bulk cargoes. Now when you add coal and fertilizers and salt and many of the other dry bulk cargoes to agricultural products, you have perhaps some growth opportunities. Grain, however, is cyclical in nature, and it is a good deal more difficult to generate the volumes necessary to keep unit trains busy when one's raw material is spread between the Alleghenies and the Rockies. So with regard to unit trains – while they are an enormous improvement in the logistical control and the logistical flow of agricultural products – to date we have only been able to find adaptations for unit train movements in any significant quantities in export markets where you have a concentration of destinations. We do not have that in the domestic markets yet, and perhaps some day that will come. I, for one, will foster it because I've seen the enormous efficiencies of unit trains in agriculture. It is, indeed, the way to go if one's objective is to eliminate waste in the cost of processing food for human consumption.

Okay, we talked a little bit about opportunities for barges, and I may have misunderstood this, but I think that the opportunities for the inland waterways are quite good. As agricultural exports expand, I think the opportunities are there for the water carrier industry to expand with it. This, of course, assumes Lock and Dam 26 is somehow satisfied and that particular issue is solved. When we look at navigable waterways, though, we must recognize that they don't go everywhere. If Allen Boyd had his way, they wouldn't go anywhere [laughter]. I have looked in the past at proposals to move grain in pipelines, and I can tell you now that at least the current state of that art renders them about as uneconomic as using the aviation industry for the bulk movement of grain. The economics simply are not there.

So I believe, as I think the rest of the panel here believes and has expressed, that technological advance to meet tomorrow's transportation needs essentially will be very slow in arriving. It has been progressive steps in the past. I expect it to continue that way, but perhaps even less so because in my view, and in my experience, I sense a decline rather than an increase in the public commitment – a public commitment to foster and to support these advances in technology. Now I'm not suggesting that the kind of commitment I'm talking about is in the form of government funding programs. Some of that may be necessary to catch up with technological improvements from past failings. Rather I'm talking about a commitment from the public which accepts the notion that the real advances in technology simply result in increased productivity. Transportation needs increased productivity to meet tomorrow's challenge. We surely need it in the agricultural industry. But technological advance is but one means of achieving that objective. And yet, we have all witnessed past advances in technology which are denied; this, I think, is shameful. They are denied their full bloom for lack of public commitment to achieve the highest standards of productivity which they offer.

This lack of commitment expresses itself in many ways. I will list four, and perhaps you can think of others. I think antiquated work rules have already been stated earlier – that, to me, is one way, one expression of a lack of commitment to improve productivity; lethargic management – and I do not just limit that to transportation companies, that's true in the shipping community as well; regulatory disincentives – hopefully, we're on the road to some progress in that area; and, let's not forget socioeconomic and sociocultural influences – now, they have their place. They all represent shortfalls. I want to emphasize that those shortfalls are not caused by a shortage of scientific or engineering brilliance, really. We have that – we have that in sufficiency to export that kind of talent, and that's what we're doing. The shortfall is in the public commitment, which in turn places a lid or a restriction or a handicap on technological advance. And but for that shortfall, I think the deterrence to optimum productivity would not be tolerated.

Mr. Springrose has more than 30 years' experience in virtually all facets of transportation with special emphasis on grain transportation. He has been a vice president of Cargill for 10 years.

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Question: You mentioned work rules as a constraint. Is this (i) what the railroad management tells you; (ii) what you have deduced yourself; or (iii) what the railroad unions tell you. More specifically, the United Transportation Union on a New England Railroad has been willing to have two-man crews (in two specific instances) to encourage new traffic. (However, none of this traffic ever developed.) If work rules are such a constraint, then how do you explain this?

Answer: This inquiry asks the basis of my comment on antiquated work rules: (i) Yes, railroad management told me. (ii) Yes, I have deduced it myself. I have observed several cases firsthand (where crew costs were a critical factor in determining competitive positions) in which existing work rules rendered railroad service uncompetitive. (iii) In conversations with UTU officials, I suggested rule modernization with job protection for all current members and was told I did not understand the internal politics of the unions. (True.)

I am not familiar with the particulars in New England alleged in the question so I do not know why the traffic did not develop. However, these are isolated exceptions and are (i) a fairly recent development of the "new climate" in union/management relationships, and (ii) they usually apply (or are restricted to) new traffic. Well, there isn't that much new traffic around and perhaps that is why modern crew rules are so sparse.

Essentially, I view the problem of outdated work rules as one of the major inhibitors of railroad ability to retain old traffic. As such, it should be considered and improved along with the other factors I mentioned. An exemption surely cannot be justified because of "internal union politics." With adequate job protection for current employees, we should at least begin the transition toward the greater productivity which modern technology already provides.

Question: As one of the largest shippers, would you support the adoption of a "standardized intermodal through bill of lading," which would replace the various waybills, freightbills, and so forth, currently existing? What problems, both technical and political, do you foresee before a document of this type would be accepted by shippers, carriers, and government agencies?

Answer: I believe a standardized intermodal through bill of lading is an important step toward computer adaptation and the control and simplification of paperwork. The value of standardization would vary depending on the industries to which it is applied.

Acceptance of such a document is more a matter of technical design than political influence. Given a design that satisfied the many requirements which gave rise to the current generation of bills of lading form, I believe the affected parties would accept it readily. This suggests that technical simplification is a necessary first step to standardization.

DISCUSSION PANEL

"ISSUES FACING TRANSPORTATION AND OPPORTUNITIES IMPLICIT FOR TECHNOLOGY – FROM AN ECONOMIC VIEWPOINT"

Remarks by
William Allman
U.S. Department of Transportation

It's kind of hard to follow or close with so many ideas already having been said under the theme "opportunities implicit for technology as seen by an economist." The list seems to grow longer with each speaker, and I'm going to try to identify three opportunities which, hopefully, will be somewhat additive rather than repetitive.

The first opportunity stems from transportation's basic mission. When we think of transportation very fundamentally, transportation is work. A scientist measures work in terms of foot-pounds. Foot-pounds or work require energy. I suggest that energy in the future, as so many have already said, is going to become a critical determinant for transportation.

In any human endeavor, there is probably a one best way, given the circumstances, to try to do it. This was advocated far back by Frederick Taylor, the so-called father of scientific management. I would question whether, given all the circumstances in a specific transportation situation, we feel comfortable with knowing what the truly one best way is. The problem is we want to get something from here to there now. We may not have time to think about the truly one best way, and it really takes time to develop one in the long run to become better. I suggest that energy is going to become the most critical determinant of that one best or better way. Isn't it natural to think that an intermodal combination might not be the one best way, if we can identify it; and of course with respect to energy, what was the one best way yesterday may not be the one best way tomorrow.

When we think of a one best way intermodally, we think of the problems associated with intermodal transportation. It's fraught with interface, paperwork, and handling problems, and divided responsibility in that no single carrier has overall responsibility, although there are very many good examples of coordination between carrying companies. But we could overcome this weakness if we avoided this divided responsibility by having total transportation companies.

Most of the regulatory subjects that have been mentioned this morning have applied to intramodal (within one) transportation. The regulatory area which seems to have had the greatest void of treatment is the intermodal (or between mode) regulatory area. A truly intermodal operation would offer a catalogue or department store of transportation, such that shipments could be completed by one carrier thereby avoiding a double responsibility or triple responsibility for the carriage. There are of course energy-saving implications here.

As an example of how young this type of thinking is, I only know of one book that's been written on this relatively new subject, namely, the total transportation company. It was written by Professor Robert Lieb at Northeastern University. Isn't it interesting that within the total subject that only one book has been written? I suggest that that is an opportunity implicit for technology as seen by an economist.

The second opportunity follows from the theme of energy, which seems to be so significant at this conference. I would like to differ with one remark of John Meyer's, namely his concern that the coal market won't expand. Carl Bagge, who is the president of the National Coal Association, and who, therefore, does have somewhat a proprietary interest in coal, recently gave a speech stating that while we currently produce 650 million tons of coal in this country, by 1985 we can expect to produce 1.2 billion tons. Now that's almost a doubling in less than 10 years. That is a significant expansion. DOT is very interested in the transportation of coal, and the ability of the nation's transportation system to accommodate it, and it has sponsored studies in this area. From an economist's viewpoint, we think that the coal has to be handled efficiently. It is very pleasing to see private research, such as that done by General American Transportation, leading to the existence now of coal hopper cars which we understand can unload 100 tons of coal in seven seconds. That's a tremendous accomplishment, relative to previously existing methods of unloading coal cars.

When you hear about this improvement and realize that coal transportation demands may double within 10 years, you really have to wonder if certain railroads are going to be sinking into the mud, or going someplace similarly undesirable, as some people allude to.

Finally, a third opportunity for economists which I would like to identify, and which I think

For the Office of Economic Analysis at DOT, Mr. Allman has responsibility for assessing the implications of proposed transportation policies and legislation. He is also actively involved in staff study projects pertaining to physical distribution.

warrants the thinking of people who are qualified in the area, relates to an article in last night's Washington Star. That article said that the cost of Alaskan oil to this country is apt to end up higher than the cost of OPEC oil. We have in the northern reaches of North America abundant oil and natural gas resources. We are planning to bring some of it down by pipeline through Alaska, though we don't yet know how it's going to get inland. But I suggest that a tremendous opportunity for national good and also an exciting research field, is how we can best get these energy commodities down from the northern reaches of this continent. Now this would have to be done in an international environment, because certain considerations would be controlled by Canada, but, nevertheless, when you read that it is possible that Alaskan oil is going to cost more than OPEC oil, shouldn't we try to do something to reduce the transportation cost of getting those energy commodities delivered by finding the one or more "best" ways to transport them?

In concluding, I thought this audience might be interested in what an informal survey at DOT revealed as to what a few DOT personnel view as the most significant past transportation technology accomplishments of DOT in the past. I want to emphasize this is based upon a small informal survey. The survey revealed that the accomplishment thought most significant was the rail FAST facility – that's F.A.S.T., Facility for Accelerated Service Testing, which is a part of the Transportation Test Center at Pueblo, Colorado, where the maintenance life and the operating life of railcars and their equipment components can be given tremendous tests at faster rates than otherwise possible. The second most prominent or significant accomplishment of DOT technology research was cited as being the oil spill fingerprinting technique developed by the Coast Guard, which enables an oil spill culprit to be positively identified, so that he can pay for the cost of cleaning up the oil spill, rather than you the taxpayer having to pay for it.

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Question: Are there not better possibilities for energy savings with a regulated motor carrier industry than with a deregulated industry? Such as, assuming government takes positive action to incite increased utilization of capacity.

Answer: Although it seems possible for a regulated motor carrier industry to approach the energy savings of a deregulated industry, it also seems that, in the extreme, a deregulated industry which offered even the slightest more freedom of operation than a regulated one would offer more opportunities for energy savings. Specifically, greater freedoms with respect to route and commodity restrictions from a deregulated industry should offer energy savings opportunities, even if only relatively small, over an "energy-conscious" regulated one.

DISCUSSION PANEL

"ISSUES FACING TRANSPORTATION AND OPPORTUNITIES IMPLICIT FOR TECHNOLOGY – FROM A SOCIETAL VIEWPOINT"

Introduction to Remarks by
The Honorable Judith T. Connor
by
Frank Hassler
Director, Office of Systems Research and Analysis, Transportation Systems Center

The topic that we are going to turn to now relates to the issues facing transportation and the opportunities for technology as seen from a societal point of view. The topic clearly embraces the economic views that we heard this morning. The economic viability and growth of the nation is clearly a prerequisite to a stable society. What we mean to concentrate on here are the issues and the viewpoints of a broader nature – broader than the narrowly defined economic issues – and on the economic impacts of these issues; and on the consequences for research and development of freight transportation systems. The panelists this morning include Mr. Frederick Bradley, Jr., Vice-President of City Bank; Dr. Ann Friedlaender, Professor of Economics and Transportation at Massachusetts Institute of Technology; John Hidinger, Director of the Office of Transportation and Land Use Policy of EPA; Gerald O'Donahoe, Vice President of Harbridge House; and Carl Rappaport, Director of Conservation Policy Office, Federal Energy Administration.

For our principal speaker, we are honored to have Ms. Judith T. Connor, Assistant Secretary for Transportation for Environment, Safety, and Consumer Affairs. She began her government service in early 1971 as policy advisor in the Office of Economic Opportunity. Later that year she joined the Department of Commerce as a member of the Secretary's policy development staff. Prior to her appointment as assistant secretary, Ms. Connor was acting deputy administrator of the Urban Mass Transportation Administration. Prior to her federal service, she was a marketing consultant, and a member of the marketing department of Trans World Airlines. She began her career as a statistician in the Pacific Telephone Company. She holds a master's from Columbia and a bachelor's from Wellesley. I am privileged and pleased to introduce Ms. Connor.

Mrs. Judith T. Connor
Assistant Secretary of Transportation
for Environment, Safety, and Consumer Affairs
U.S. Department of Transportation

When Mrs. Connor was sworn in to her post on October 24, 1975, she became the first woman to hold the title of Assistant Secretary in the Department of Transportation. She began her government service in early 1971 as a policy advisor in the Office of Economic Opportunity. Later that year she joined the Department of Commerce as a member of the Secretary's policy development staff. Prior to her appointment to Assistant Secretary, Mrs. Connor was Acting Deputy Administrator of the Urban Mass Transportation Administration.

CONFERENCE PAPER

"ISSUES FACING TRANSPORTATION AND OPPORTUNITIES IMPLICIT FOR TECHNOLOGY – FROM A SOCIETAL VIEWPOINT"

Origins of Perspective

I have been asked to address the issues facing transportation – and opportunities implicit for technology – from a societal viewpoint. Since I am neither a technologist, nor a sociologist, I perhaps should start by being an apologist – and explain to the best of my ability why I am occupying this spot on the program.

Perhaps the simplest explanation is that I have almost all of the right words in my official title – environment, safety, and consumer affairs. I say "almost" because somebody left off the word "energy," which would make the litany quite complete. The point, of course, is that my function does encompass those aspects of policymaking which are primarily "societal" in their emphasis.

Another way of looking at my assigned perspective on technology is to label it as a concern for the "quality of life." Or, a more creative label is the one suggested when I was invited to be the speaker today – Mr. Baker called it the "not-for-profit" perspective.

I hasten to add that I am not happy with any of these labels – societal, social, quality of life, not-for-profit – because they immediately stir up what I consider to be counterproductive images.

In the first place, they tend to suggest that anyone who is in this kind of business is by definition muddle-minded, emotional, irrational, and otherwise confused about the foundations of our economic system. We spend all our free time (and much of our paid time) dreaming up sinister ways of throwing blocks into the wheels of progress and undermining to the best of our ability the incentives for free enterprise and self-determination. This view was reflected in the latest edition of Fortune magazine. I'd like to read to you the opening paragraph of a featured article entitled "It's Time for New Approaches to Pollution Control."

> Sometime late in the Sixties, pollution ceased to be a morally neutral problem subject to rational analysis and balanced solutions; it acquired, instead, the status of sin. Congress wrote tough legislation – the Clean Air Act amendments of 1970 and the Water Pollution Control Act amendments of 1972 – to stamp it out. What the amendments added up to were decisions by the U.S. Congress not only to rearrange a considerable number of American habits and

institutions, but also to repeal some laws of economics, physics, and logic (p. 129, Nov. 1976 Issue).

The article then refers numerous times to "Environmental Puritans" – invoking in each reference the spectre of religiosity run rampant. However, at no time does the author of the article disagree with the basic endeavor to clean up the environment. In fact, the main point of the article, as I understand it, is that the current legislated approach to the problem is misguided, and the use of a penalty tax system would reap sounder results. So the author is arguing about means, and not ends. But, by innuendo, the author is suggesting the environmentalist has in some way vetoed a system build on incentives, which I suspect is not the case. I also suspect the legislative route was taken because (1) it is the most practicable; and (2) it was the only serious option presented.

I do not concur in the belief that environmentalists are determined "to repeal some laws of economics, physics, and logic." In fact, I suspect I can claim to be at least as conservative when it comes to a belief in reason and in free enterprise as any other self-respecting Neanderthal. I have not found this bias to conflict inherently with the fulfillment of my responsibilities nor my conviction of their importance.

The second reason why I do not like the standard perspective on my responsibilities is because it tends to carry the connotation that the functions must be "layered on top" of predetermined actions. In other words, decisions have been made (in the government they would be referred to as "programmatic" decisions), the direction is set, action is under way, and "we" raise our ugly (or at least unwelcomed) heads and say "whoa" and "wait." The wait is usually costly, divisive, and seemingly endless. In fact, if the offices I oversee have anything in common (and that's debatable), the common thread would be the tendency to be considered after-the-fact nuisances to the modal administrations. Later in the speech, I'll explain more fully why I believe this perception to be unfortunate and counterproductive.

Redefinition of the Perspective

Why is it necessary to present the societal viewpoint to an audience such as this in the first place? Because things are changing – not necessarily daily – but certainly at a faster pace than they used to! And if we are going to be effective in any endeavor, we have to learn how to adjust and manage our responses to societal change.

Of course the root causes of change are both human and natural. We invent, we discover, we grow and develop. We capture these changes in artistic expression and usually look back at them with some degree of amusement. But, we tend to look forward with some degree of trepidation, a fear of the unknown or a distaste for the evolving. Clearly this is because changes in the physical surroundings always result in restructuring of values and this, in turn, leads to restructuring of basic institutions and processes in response to these values. These changes affect the business community, governmental structures, religious and academic institutions, among others. No wonder the changes are unsettling – particularly for those of us who liked things the way they were!

The point, though, is that the trend toward an interest in the quality of life cannot be viewed as if it were something that other people have thought up and which can be adopted or fought off or ignored, depending on one's view of the new values. The fact is that we are experiencing a fundamental change in societal values and are witnessing the ways in which our institutions are internalizing these fundamental changes.

Since I don't want to be accused of spewing out a Connor version of social or economic philosophy, let me quote from a reasonably respected (if not entirely accepted) student of our business society. Robert L. Heilbroner recently published a disturbing little book called Business Civilization in Decline.* I commend it to you not because I agree with it all, but because it stimulates some real controversy on the subject of the future of our capitalistic system – given recent social and economic trends. Mr. Heilbroner identifies three phases of governmental intervention into the economy based on the underlying purpose of that intervention. The first purpose was as a direct stimulus for economic expansion. This phase covered the period in time from colonial America into the early to middle decades of the nineteenth century. Mr. Heilbroner says this "is the era during which federal and state money made possible the network of early roads, canals, and railroads (not to mention public schools) that played an important role in imparting the momentum of growth to the formative system." (p. 23)

The second phase of governmental intervention was the regulation of markets. And, again, I quote: "In one manner or another, the new agencies sought to bring order to markets in which the competitive process was threatening to bankrupt an industry (farming), or to undermine its reliability (banking), or to demoralize its operations (utilities).

*Heilbroner, Robert L., Business Civilization in Decline, W.W. Norton and Company, Inc., New York, 1976.

Indeed, one of the insights that radical historians have given us is the recognition of the role played by leading businessmen in actively promoting regulation in order to stave off the cut-throat competition and other evils they were unable to police by themselves." (p. 24)

The third phase, which started with the New Deal and is still here, is the "active use of central government's powers to bring the economy to an acceptable level of employment, growth and welfare." (p. 25)

Mr. Heilbroner concludes that in the long run, capitalism must give way before the mounting difficulties of the environment and the waning convictions of its own citizens. At this stage, as I suggested earlier, I am inclined not to agree with this conclusion – if I'm permitted the hubris to question it. I do agree that there will be changes; I just don't seem to have a clear enough crystal ball to be able to see whether they will be so dramatic as to push us into an entirely different economic system.

In the interest of stimulating debate, I present Mr. Heilbroner's conclusions. But I quote his three stages primarily to demonstrate that I am not the only one around who believes we are witnessing fundamental changes in values – changes that are being reflected in our institutional reactions – in this case, in the role of government.

Change for Technologists

Of course, I don't need to tell an audience of technologists, many of whom have probably been watching trends in government support extremely carefully, that the bloom is off the 1960's rose. We discovered early in the 60's that man might indeed make it to the moon but it didn't take too long before we realized that feat would have little to do with developing direct solutions to our social problems. After believing firmly that the other guy might be able to perform miracles, we discovered that none of us appeared to have the answers to mundane problems. This discovery, in addition to our unfortunate international involvements of the time, lead to a great deal of social upheaval, rejection of the status quo, and a tendency for our citizens, particularly the younger ones, to express their views openly and vociferously. The skepticism was, of course, exacerbated by the abhorrent revelations about leadership qualities under the Nixon regime. Consequently, a large proportion of the population no longer believed that decisions were being made in the best interest of the public, rejected the practice of closed leadership and, perhaps even more importantly, felt they could do as well if given the opportunity to do so.

In 1969 we saw the landmark legislation called the National Environmental Policy Act (NEPA). This act captures the new feelings perfectly by requiring primarily a "process" with respect to environmental planning. This process assumes extensive evaluation of those actions which do or might affect the quality of our human environments, and assumes extensive involvement of the public in this process. At the same time, we witnessed movements toward "participatory management" in both the public and private sector, there were town meetings and public hearings, there were demands for representation – from minorities, from women, from special interest groups, particularly consumer groups. And trends at the federal level are unlikely to change because we now have a President-elect who appears to be comfortable being called a Populist.

Like the business or government decision-maker, the technologist has become suspect. First of all he promised us great inventions, but after accomplishing them, the man on the street felt no better off than before. Secondly, he used his technology for inhumane acts (napalm) and for potentially startling alterations of natural acts (like foretelling or even predetermining the sex of a child). Finally, he seems to have pooped out of simple ideas just when we need them most to solve problems with productivity, urban congestion, energy usage, to name a few. Therefore, the technologist, as much as anybody else, has lost his credibility and will be equally subjected to the new tendency for open review and evaluation.

How to Cope

Daniel Moynihan wrote a book recently which was delightfully entitled, Coping. As usual, Mr. Moynihan captured the mood of the day.

How do we cope with these new events?

Well, the first thing is to face up to them. Any of you who may have heard me talk before, have probably heard me play this theme. I do it not because I like to lecture, but because I have developed a martyr complex. The complex is the result of being blamed on a regular basis for the delays and disruptions that are caused by my office in the course of carrying out its assigned responsibilities. I know we cause delay and disruption, but I promise you it is not because we like to be perverse. It is my firm conviction that most of the uproar could have been avoided in most cases if the programmatic office had faced up to the spirit, in addition to the letter, of the new laws and the new societal trends. This takes me back to my earlier reference about layering quality-of-life considerations on top of fully formed programs. The best responses come from those parts of the department that integrate these considerations into their decision-making processes early in the game. When you start to design a downtown people mover, like UMTA is talking about today, have you made provisions for considering both safety and security features? Are you thinking about our handicapped population? Will it be environmentally sound, including all the energy, aesthetic, and pollution factors? Have you held public hearings in the locations where people will be most affected? Or, are you going to follow the example laid before us by the ill-fated Pittsburgh Skybus where we discovered well after the planning fact and well after considerable political and financial commitment had been made that the people didn't like the idea – they didn't like its aesthetic intrusion – they didn't like the thought of no drivers, because it made them feel insecure and unsafe. Perhaps even more to the point, they expressed reservations about such a far-out system when their streetcars, buses, and highways were working to a reasonable degree of satisfaction.

Let me give you a couple of good examples of facing up to the spirit. The first one to come to my mind involves a private sector company. I am sure many of you know of the outstanding example set by the 3M Company, in the area of pollution control. The program is spearheaded by Mr. Joseph P. Ling, vice-president for environmental engineering and control, who is credited in a recent Business Week article (November 22, 1976, p. 72) with telling his top management that in the face of the recession and subsequent cost-cutting, he could not shave dollars off pollution control. Ling is quoted as saying, "the government wasn't going to ease up its requirements just because the economy was down, but I explained that if we didn't discharge pollutants, we wouldn't have to pay to clean them up." Thus, the corporate goal was "to get personnel to stop thinking about pollution removal and instead stress product reformulation, equipment changes, process modification, and materials recovery." Of course, the 3M Company expects to design pollution control into any new construction plans, which is a perfect example of integrating new concerns into your way of doing business. It is also my understanding that in attempting to develop industrial technologies that do not pollute – or make use of waste products – some companies are discovering that they are not only saving money by eliminating the need for pollution control equipment – in some cases they are developing more efficient production equipment, and better or less costly products.

Of course, another example of facing up to the spirit is the one set by Secretary Coleman in his brilliant technique of using public hearings as a part of his decision-making process. For technologists, his Concorde decision is certainly a model as a means of introducing a new and suspect product. The opponents to supersonic aircraft still do not like the decision, they still sued, but they cannot say that they were not heard and given every consideration prior to the decision itself.

What Does This Mean for Freight Transportation?

So, having used up almost all of my time talking about the societal perspective, what does this perspective mean to you? What does all this mean to freight technology and the transportation of freight?

You know better than I about the outlook for new technologies and I don't wish to find myself trying to outguess Hamilton Herman – particularly in the area of hardware development. But I would like to make a few guesses about our technologies, using the preceding comments as the basis for these guesses.

My first guess is that we will find our R&D efforts oriented to the development of those technologies which are in line with our new values. These technologies may not be the sexiest we have seen, perhaps not even as sexy, but they will be consistent with the concern for quality of life. For example, I think it is much less likely that we will chase after brand-new forms of mass transportation (like the Morgantown experiment, Skybus, and BART cars) and will instead focus on design features for our current vehicles, both public mass and private auto which will make these vehicles more desirable. Metro has already done this in Washington by opting for an older and more proven subway car design. The specs stressed evenness of ride, safety, quietness, etc. The efforts to conserve energy on subway cars through the use of flywheels is another example of compatible design. We will see, for example, quieter, cleaner, and more efficient trucks. We know now that we will be placing a high value on quieter airplanes, and since a large proportion of air freight moves at night, appreciation for the effects of aviation noise should not be underestimated – witness the Massport experience, and its aftermath. We might see increased interest in the railroads as developing shippers in the sense of providing growth capacity – but I doubt it. Note my emphasis on growth capacity (not utilization of current capacity). I say this because although it appears reasonable to assume a relatively clean and efficient transportation mode such as railroads should be able to blend beautifully with the new scenery, I personally believe there are too many forces working against any stupendous thrust toward revitalization. Among these are the following:

- Like buses, railcars are only energy efficient if they are loaded up. Car utilization techniques are still so hopelessly outdated as to suggest extreme difficulty in overtaking the efficiencies and scheduling associated with trucking.

- Our population appears to be showing a consistent interest in nonurbanized areas. Industry can now locate its plants in rural areas and attract a lot of skilled and semiskilled labor. Unlike the dispersal of population that took place in the 19th century, the current spread need not be confined to following rail lines. Truckers are ubiquitous.

- Railroads are not good neighbors because they are noisy and can be dangerous. Consequently, I believe railroad management will find expansion difficult. Abandonment is one thing — no one seems to want to lose a rail line, except an occasional railroad. But expansion or rerouting proposals are another — and will probably run into the same flack that is being caught today by urban interstate highways.

- It may be risky, but my list would not be complete without reference to railroad management, unions, and regulators. They show no signs of being innovative; and technological development depends on the innovative spirit.

My second guess would be that those technological concepts which are new will be extremely difficult to introduce and will take experience, savvy, and sensitive leadership to achieve fruition. Unless you understand the new trends and know the way the game is played, you will feel hard done by when you run into the stonewall — which is very likely to be the proverbial "little old lady" and her lawyer (and all her neighbors and You-Name-The-Club members). Witness the proponents for the U.S.-built SST — they still believe (perhaps correctly, I am not debating the merit) that the defeat was the death knell for new generations of passenger aircraft. Witness the proponents for heavy rail urban transportation systems — they still cannot believe that the relatively short-term disruption associated with downtown construction, and the growing concerns over capital costs and long-term financial projections can be so serious as to make the Feds question how many more white elephants should be built! Witness the proponents for the so-called Buck Rogers urban technologies: dual mode, electric cars, horizontal elevators, and the like. They still cannot believe that we have not funded the R&D sufficient to bring about the technological answers.

What these proponents fail to see is the sociological and institutional constraints on these kinds of invention. Like Pogo, the populace seems to have said, "I have seen the enemy and it is US." Pogo will need to be convinced that the enemy can be either conquered or tamed, and that the costs of doing so are worth the effort. I believe this applies, by the way, to the introduction of mundane as well as advanced technologies.

Let me give you an example of what I mean — in the area of the mundane. A lot of us in DOT and a lot of people in several key cities have been talking for awhile about the feasibility of freight distribution centers. The rationale is simple; freight is collected, preferably in containers, and delivered, probably by truck, but possibly also by rail and ships, to a single distribution center in the destination urban area. The freight would then be broken up for delivery into quadrants of the urban area. Of course, the benefits would be better utilization of vehicles and facilities, better security, better scheduling and increased energy efficiency. I think the idea is a good one and that we should try it; but I'd bet money that we will have trouble selecting the site for the center (even recognizing that some have already been proposed). Why? Because it doesn't seem to me that such a center will be a good neighbor. It will be the source of considerable noise, activity, congestion and the like. Semi-residential neighborhoods certainly won't want the noise and activity; industrial areas won't want the congestion. We still ought to try it; but the idea will take careful community planning and selling.

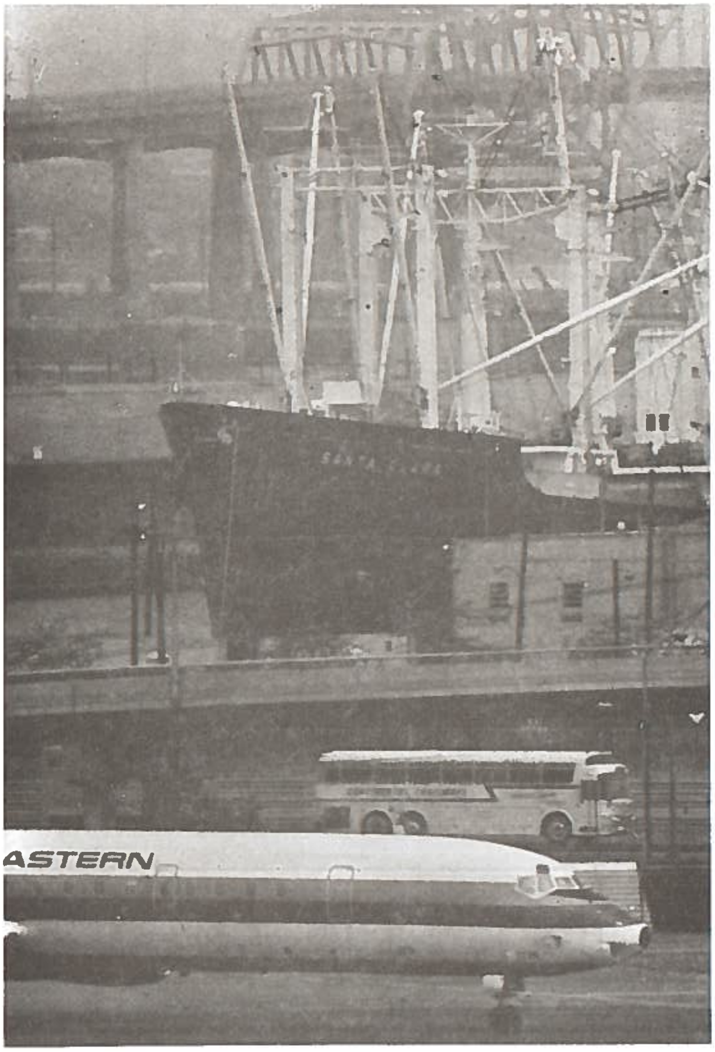
Another guess. I would guess that the degrees of difficulty associated with developing acceptable technologies, and the degrees of difficulty associated with the process of introducing any new technologies (including regulatory difficulty, by the way) will force you to place greater emphasis on utilizing the present infrastructure — making better use of what you've got.

As many of you know, one of my offices oversees programs dealing with the facilitation of goods and people. I originally wondered whether or not there was a legitimate mission for this office — asking myself always why the federal government should get into such an exercise. In order to satisfy my curiosity, I spent a great deal of my own time mucking around in matters of facilitation. In fact, in addition to becoming fascinated with the subject, I have convinced myself that the mission, if properly stated and pursued, is critical to the efficient use of transportation facilities. For those of you who don't know, this office focuses on the means of simplifying travel or shipping documents and, in the next logical step, is attempting to encourage the use of data interchange by assisting in the developing of common codes, standards and formats. I have traveled extensively to shippers and carriers in an effort to assess the needs in this area and I can tell you in all honesty that I am appalled at the state of the art. Even those companies that are known for their progress are using incredibly simplistic methods of record-keeping, control and inventory and warehousing techniques. I don't mean to sound harsh, because I can tell by the degree of pride displayed by those managers who have introduced good systems that their achievement must have followed many hard hours of debate, haggling, and cliff-hanging. But, quite frankly, I learned how to write computer programs back in 1961, and the problems we were working on then were simple inventory problems. The capability of these types of management control techniques seems only now to be penetrating into the freight transportation field.

Let me give you some specific examples, without using specific names. One major chemical producer I visited had become so disgusted with the inability of the railroads to locate his cars — or perhaps their ability to lose them (as you know, for the most part tank cars are owned by shippers) that he decided to develop a tracing system of his own. He had developed the system at his own expense but it worked only because the producer was so big that he could have company people at his many locations keeping track of the movement of the cars. Great idea but, can you believe it is 1976? What about the railroads? What are they doing in this area?

Well, I went to see two railroads; one here and one in Canada. They were among those that are considered "advanced." These two railroads were beginning to offer similar services to customers but could do so only if the loaded car stayed on their lines. If not? Poof — lost it again. Why? Lack of agreement on communication protocols between railroads. I also discovered, by the way, that these two railroads were desperately trying to eliminate the piece of paper that travels with every shipment and gets passed from greasy hand to greasy hand. This was tough to do though. Why? Because DOT regulations require it in many cases, particularly for hazardous materials.

Where does this lead us? I'd like to do it as we have done before, with a strong sense of adventure as we search out profit potential. But few adventurers have left the dock without some kind of map and decent guidance, even if it be guesswork. I've given you a few of my guesses as guidance in the area of societal imperatives. The adventure is up to you to accomplish.



DISCUSSION PANEL

"ISSUES FACING TRANSPORTATION AND OPPORTUNITIES IMPLICIT FOR TECHNOLOGY – FROM A SOCIETAL VIEWPOINT"

Introduction to Panel by
Frank Hassler
Director, Office of Systems
Research and Analysis, Transportation
Systems Center

Thank you, Judith, for some very timely remarks. I think you've helped to underscore many of the key issues that this panel should continue to embellish upon. Following in Charlie Baker's mode, let me try to underscore a few of the key issues which perhaps should be put on the agenda for the remainder of these discussions.

The first, I think you said, was that environmental concerns, in particular pollution, can be viewed either as perturbations upon the real, fundamental development of the nation's freight transportation systems, or they can be viewed as increasingly realistic concerns in their own right as the scale of societal operations begins to run into the finite earth constraints. And, in that sense, they represent new values that won't go away.

I think the second issue that you raised was the issue of planning, and the role of planning in the development of freight systems or any system. I believe the points you made were that the planning process must be more broadly based, open to public participation, more justified and justifiable – both from the point of view of acknowledging the broader human values and justifying the particular development under concern.

Which leads to the third point, which you highlighted in your example of 3M Company – that is the increasing need in our planning for a focus on process efficiency. I think the point you made was that the broader concerns of things like environment need not be contrary or counterproductive to the primary concerns of good economics or good design. But that, in fact, often, if taken into account early enough in the planning process, can lead to a better overall product.

I think that fundamental observation holds across a wide range of topics. For example, the evolution of automotive technology is now beginning to combine considerations of economics, fuel efficiency, and environments safety and performance in an intelligent way.

In some work that we're doing here at the Center, attempting to characterize the economy in general from the point of view of both process efficiency and mechanization, the evidence would seem to suggest that historically over a long period of time, mechanization as a principal technological objective has been more important in increasing labor productivity than has process efficiency. If your remarks are correct, perhaps a fundamental change confronts technologists, in the sense that process efficiency will become a more dominant theme, and pure mechanization will become less important.

Of particular concern in the process efficiency area is the role that speed in transport plays in societal processes. Speed increases historically have accelerated societal logistics, and added greatly to the productivity of the processes that transport supports. This can be tied as a theme to John Meyer's hierarchical remarks. He suggested, for example, that in the early phases of transport development, physical logistics restraints were of primary importance, but that as the economy evolved, the service industries in particular and the higher order economic processes have become more important, and the pure physical characteristics of tonnage movement have begun to grow at less than the GNP growth rate. If so, tonnage value will continue to increase in importance over tonnage, quantity and speed of transport will dominate over low-cost capacity as important trends in freight system planning.

If your remarks, Judith, can be used to generalize the theme of this morning, higher order value concerns in social planning will also now have to be factored into the equation, and lead to a much greater emphasis on efficiency in the planning process. So the conclusion that you reached, I think, can be stated in the three guesswork areas that you have outlined: First, that these new values will be the ones that drive R&D and freight systems in the future; second, the new technology will be comparatively harder to introduce into the economy than has been the case previously; and third, much more emphasis will have to be placed upon better and more productive use of the systems that we have. Thank you.

Our first panelist is Mr. Frederick Bradley, Vice-President of City Bank.

DISCUSSION PANEL

"ISSUES FACING TRANSPORTATION AND OPPORTUNITIES IMPLICIT FOR TECHNOLOGY – FROM A SOCIETAL VIEWPOINT"

Remarks by
Frederick W. Bradley, Jr.
Vice President
Citibank, N.A.

As a banker primarily involved in aviation I should like to limit most of my comments to the present status and future outlook for domestic air freight. Ms. Connor states "that the airlines must wake up to the fact that there is an air cargo market out there" and that air freighters, if used properly, could assist in enhancing the profitability of the airline industry.

I do not disagree with Ms. Connor but unfortunately there have been and still are obstacles in the way of air freight coming into its own.

More than 20 years ago before I became a stodgy New York banker, I was associated with a transportation research firm here in Boston. Our mission at that time was to determine the economic viability of a large-scale international air freight operation utilizing a proposed turboprop military freighter that was being developed by the Douglas Company. The proposal was that the aircraft would be made available to commercial airlines at a dollar a year if it could be determined that the operating revenues of a commercial air freight operation would exceed the expenses so that there would be no further drain on the federal treasury. If this could be established, it was felt that the military could save the cost of maintaining such a fleet during peace time and still have the lift available in an emergency.

The results of our study were disappointing. In order to cover the projected operating costs of the aircraft the rates that would have to be charged the shipper were substantially higher than other forms of transportation after taking into account the higher costs of handling on both ends of the shipping cycle via surface modes and the obvious reductions in inventory due to the substantially shorter time sequence as through moving the goods by air. Based on these findings the project was abandoned.

Obviously in the last 20 years considerable progress has been made in aircraft technology to improve the prospects for air freight and indeed the growth of the air freight industry during that period has been substantial but nowhere near what had been anticipated at that time. We are still waiting for that great future to materialize.

For the domestic trunks in 1975 total freight revenues amounted to $991 million compared with $13.4 billion for all services or 7.4 percent of the total. Also as of year end 1975 the Domestic Trunks had 1,758 aircraft in operation with only 59 devoted exclusively to freight operations or 3.4 percent of the total fleet.

A significant percent of these aircraft are utilized in long-haul international operations where the prospects for profitability are much greater than on the short-haul domestic routes. Indeed, of the two all-cargo carriers, one is entirely international and only 43 percent of the revenue ton miles of the other are flown on domestic routes. Most of the present and projected all-cargo B-747 lift is devoted to international routes. For example, Northwest, one of the more aggressive carriers in the cargo area, flies only 58 percent of its RTM's on domestic routes and this percent of domestic to total revenue ton miles is expected to decline further.

In short, the domestic movement of freight by air has a long way to go. Clearly the only way an airline can make money on domestic freight today is to use the belly of passenger aircraft, particularly wide-bodied aircraft. In light of the earnings problems that the carriers have experienced in recent years they cannot be expected to devote more energy to freight operations unless there is a reasonable expectation of an adequate return.

Unfortunately, regulatory policy plays a role in restricting the growth of domestic air freight. Although it is generally agreed that present rate levels do not permit the carriers to earn an adequate return on their freight operations, as yet there has been no decision forthcoming from the Domestic Air Freight Investigation. As in the case of passenger fares there should be a more realistic relationship between fares and costs to permit the carriers to earn an adequate return on investment.

Another limiting factor relates to the upcoming noise and environmental regulations which are the subject of hearings at the Department of Transportation in Washington today. Most of the old freight aircraft and combination aircraft would be subject to these regulations and would involve substantial retrofit costs with no economic benefit.

Mr. Bradley has held a number of key positions at Citibank including senior credit officer, vice president in charge of the Airline and Aerospace Department, and vice president of the Transportation Department.

Indeed in some cases there would be an economic penalty. It would seem to make much more sense to solve the environmental problems over a longer period by permitting the carriers to replace older aircraft with newer, more efficient aircraft, which will become an economic necessity anyway by the mid 1980's. To force carriers to retrofit existing uneconomic aircraft in the short run will inhibit their ability to finance new aircraft that will have the capability to carry freight more economically.

In short, without a more realistic approach to freight rates and environmental considerations on the part of government regulators it is hard to see a greater commitment to air freight on the part of the carriers or their lenders.

As a banker the key ingredient from our point of view is that a transportation company, whether it be a railroad, trucker, airline, or water carrier, must be profitable and generate sufficient cash to encourage us to lend the funds to modernize their equipment and systems, and thus benefit the shipper, with some confidence that we will be repaid. With a few notable exceptions the record has been good, but there is no question that lenders are looking at the industry with a more critical eye than a few years ago.

DISCUSSION PANEL

"ISSUES FACING TRANSPORTATION AND OPPORTUNITIES IMPLICIT FOR TECHNOLOGY – FROM A SOCIETAL VIEWPOINT"

Remarks by
Dr. Ann Friedlaender
Professor of Economics and Transportation
Massachusetts Institute of Technology

Role of Income Distribution

In addressing the opportunities facing technology, Judith Connor stressed many societal issues: the environment, safety, community values, planning, and so forth. She did, however, omit one issue that I think is very important. This is the role of the income distribution or, more generally, questions of equity. And it is upon this issue that I would like to address my comments.

As a neo-classical economist, I have spent a considerable amount of time and energy analyzing the efficiency of the allocation of resources in the transportation industries. As a political economist, however, I have been struck by the fact that transportation policy seems as much oriented toward questions of equity and maintenance of income to certain groups as with questions of economic efficiency. Indeed, the ICC, at least, seems to have based many of its policies on the social goals of the maintenance of income to rural and agricultural interests. Thus, if we neglect the impact of technology on the income distribution, we clearly neglect a crucial element in the decision-making process of the policymakers.

Let me expand on this a little bit. While it's something of a caricature, I think that one can argue that the ICC policies have really been geared to the maintenance of a rate structure that is based on cross-subsidization from suburban and urban interests to rural and agricultural interests. By cross-subsidization I do not necessarily mean that the rate structure ensures that the railroads make losses on their rural and agricultural traffic, but I do mean cross-subsidization in the sense that the railroads are prevented from maximizing their profits on this traffic.

To this end, traditionally and currently, the rate structure encourages low rates on agricultural and bulk commodities coming from the West and high rates on manufactured commodities. The idea, of course, is that the railroads make profits on the high-valued manufactured commodities and with these profits cover their losses, relatively at least if not absolutely, on the agricultural commodities.

If we look at certain kinds of technologies with this rate structure in mind, we can get some insight into the attitudes of the regulators toward their adoption. In particular, if we look at the Big John cars, it is generally accepted that the ICC played an obstructionist role in that particular case. The Southern Railroad wanted to introduce larger hopper cars to cut its rates, and was blocked for a considerable time from doing this by the Interstate Commerce Commission. Because the introduction of the Big John cars was going to be accompanied by rate reductions to agricultural areas, this may appear to contradict my argument. Nevertheless, insofar as the introduction of the Big John cars would have led to a substantial reduction on grain rates on these particular shipments, it is probable that it would have created pressures for similar reductions on other traffic. Although the Big John rates were doubtless compensatory for those particular shipments, it is questionable whether they would have been compensatory on other shipments. Thus it is quite likely that the ICC feared that the introduction of the Big John rates would have upset the rather delicate balance among the various rates and therefore would have led to a disruption of the traditional rate structure.

Similar problems present themselves when we consider the introduction of other technologies. Consider the case of double bottom trucks, which appear to make a lot of sense on the interstate highway system and similar highways. However, the problem with double bottoms is that they would erode rail traffic and thus reduce whatever profits the railroads may still be making on high-value commodities. Again, to the extent that the railroads lose money, or at least fail to make sufficient money, on their high-value traffic, it would be more difficult for them to maintain low rates on agricultural and bulk commodities that are not water competitive. Thus an erosion of high-value traffic would lead to pressure to raise rates on captive agricultural traffic with concomitant reductions in real income in rural and agricultural areas.

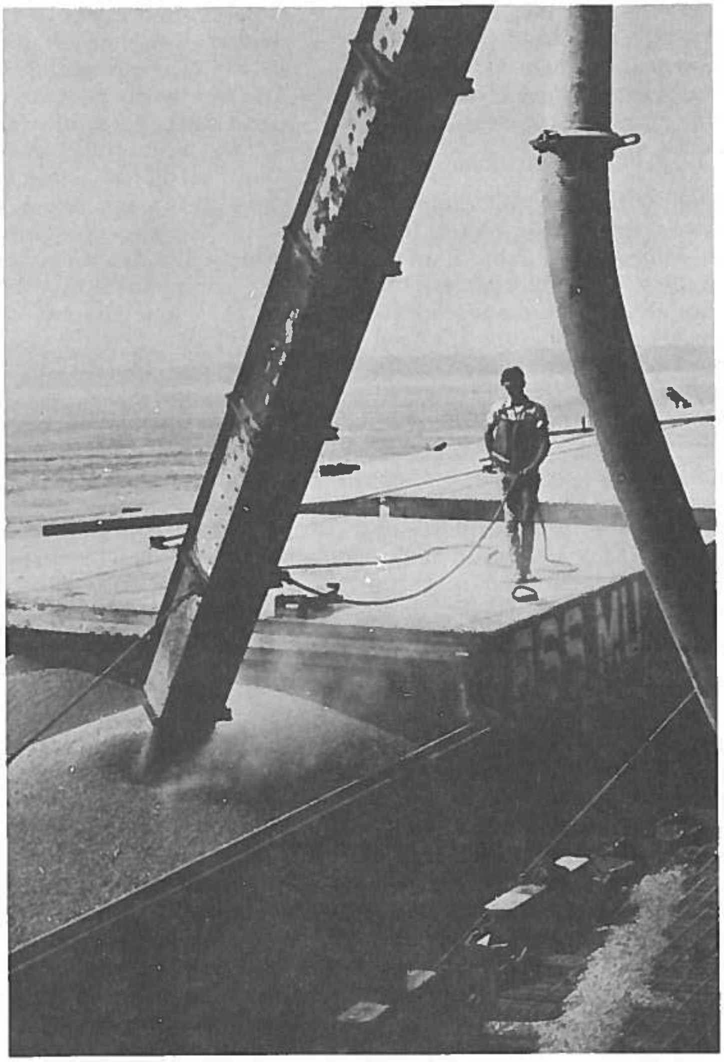
Similarly, as an economist in favor of economic efficiency, I would make a strong argument for aggressive use of intermodalism. This implies the abandonment of branch rail lines, the substitution of trucking service for light density rail service, and more use of piggy-backing. The problem with this, of course, is that one can document numerous cases in which abandonment of rail lines will impose specific hardships to specific shippers.

In addition to her teaching experience at M.I.T. and Boston College, Dr. Friedlaender is the author of many publications on transportation and economics, including The Dilemma of Freight Transport Regulation.

Insofar as the maintenance of income levels to existing shippers is an important consideration, the ICC will tend to object to that kind of intermodalism and that kind of substitute service.

On a more positive note, however, unit trains and multiple-car shipments may provide an opportunity for the introduction of technology that will work in accordance with the interests of the existing rate structure. In particular, unit trains and large-volume shipments are cheaper than small-volume shipments. Thus, if these lower costs can be reflected in reduced rates, unit trains should be a case in which the interests of the Interstate Commerce Commission, the interests of the railroads, and the interests of the agricultural and the rural groups are all in accordance.

Let me close by stressing the role of the maintenance of income levels to rural and agricultural areas. I think the ICC clearly worries a great deal about the impact of the transportation rate structure upon rural and agricultural incomes. It therefore looks at the introduction of changes in the rate structures and the introduction of new technologies with a rather jaundiced eye, because it fears that major changes in the rate structure, either occasioned by the introduction of new technologies or other things, may lead to reductions in rural and agricultural incomes. Thus, as economists and as technologists, in assessing technological change and development in the transportation industry, we clearly have to pay attention to the impact of these developments upon the income of rural and agricultural interests, affected shippers, and affected carriers. Thus, even if a technological breakthrough may lead to substantial efficiency gains, if it also leads to substantial income losses to any one group, we will probably have to reassess its desirability because it is clear that income maintenance is an important consideration of transportation policy.



DISCUSSION PANEL

"ISSUES FACING TRANSPORTATION AND OPPORTUNITIES IMPLICIT FOR TECHNOLOGY – FROM A SOCIETAL VIEWPOINT

Remarks by
John O. Hidinger
Director, Office of Transportation and Land Use Policy
Environmental Protection Agency

I think it is getting to be a cliche at this conference that you really can't develop technological solutions in a vacuum, and there definitely is a need to package together the engineering and technological solutions to our problems with the social, environmental, and institutional solutions. Just one quick example that has to do with intra-city goods movement – in New York City we have a concern about the amount of pollution that is being caused by the antiquated goods movement within the city. I don't think that the solution, although it may help, is really technological. It really has to do with institutions. And how you can effect a solution while still not impacting with any great adversity on unions, the way that they do business in the garment district, etc., etc., etc.

Let me, in keeping with everybody else, I think, add another issue to the list of issues that are being jotted down somewhere. John Barnum mentioned it in his opening remarks; that is, the issue of land use, land use and growth management. I think it's time that we brought concerns for land use out of the closet now, after they've been in the closet for the last two years. One very practical, I think, aspect of land use is that there is a tremendous amount of secondary impacts from transportation projects. Take, for example, a committee that I served on when I worked in Delaware – the committee to examine the feasibility of a superport, and the impacts of a superport in the Delaware Bay. From the concerns for a certain proportion of the environment, that is, the concerns for oil spills, a superport would have made a lot of sense because you could have reduced the amount of lightering (off-loading oil to barges to reduce draft of tanker), the amount of Delaware River traffic that was occurring, and you could have contained the transfer of oil in a much more systematically and technically sound fashion. However, the land side impacts of that superport and the development of the associated petrochemical industries that would come along with it caused Delaware at that time to reject the superport. The citizens and the governor of the state have still held to that premise.

There's another example of a hypothetical superport that may want to locate in an area that is already experiencing very severe air pollution problems. The introduction of the superport in and of itself may not add pollution, but the kinds of secondary land use impacts that will come along with that superport are going to add significantly to the amount of pollution which the community is already experiencing. And the question here is, can technology in any way reduce those adverse impacts and allow that kind of development to take place? I'm not sure that there is an answer to that, and I'm not sure what the federal perspective should be on that kind of local land use decision.

Let me also look at the subject that was mentioned by John Meyer: mine-mouth power plants. There's a number, I think, of environmental concerns that are going to affect the location of mine-mouth power plants or coal-fired power plants in general. One of those is the Clean Air Act's concern for the prevention of significant deterioration of air quality in areas that are already clean. This is a subject that has been debated both in the courts and most recently by the last session of Congress; the courts had determined in an earlier Supreme Court opinion that the Clean Air Act does, in fact, require the prevention of significant deterioration of air quality. We developed regulations and promulgated those regulations, but at the same time we went back to Congress and asked them for a clearer definition of what "significant" meant. That became a major issue in the debate that went on with the Clean Air Act amendments this year. As you know, the Clean Air Act amendments did not pass this year, but they probably will pass next year. And both the House and the Senate bills contain provisions for the prevention of significant deterioration. What this means is that there's going to have to be an examination in terms of where we're going to site coal-fire power plants in the trade-off of the cost of transportation, and the cost of pollution control equipment, while at the same time protecting some very critical and sensitive environmental areas.

So into your discussion and onto your agenda. I think we should add another term, the land use impacts of transportation technology.

Prior to joining EPA in 1974, Mr. Hidinger was director of transportation for the Delaware Department of Highways and Transportation. He also served as director of the Wilmington Regional Planning Agency.

DISCUSSION PANEL

"ISSUES FACING TRANSPORTATION AND OPPORTUNITIES IMPLICIT FOR TECHNOLOGY – FROM A SOCIETAL VIEWPOINT"

Remarks by
G. Gerald O'Donahoe
Vice President
Harbridge House, Inc.

I have been listening to this very interesting discussion by the Secretary and the panel from the perspective of one who has been concerned with policy formulation and analysis, particularly in recent years with a congressional perspective. I realize having a congressional perspective at a conference sponsored by DOT is a little like having a coughing fit at the symphony. But legislative policy does, directly and indirectly, affect technological developments.

I'd like to underscore the point that these societal concerns examined by Ms. Connor are not going to fade away. They're here to stay for a good long while. One of the effects of their continued presence in transportation policymaking is the end of a dream, or perhaps a fantasy. The dream is, and perhaps it was only mine, of an all-embracing, analytically or rationally derived national transportation policy. I think that dream is over, because the analytical tools to embrace social concerns are very weak. They're uneven at the program level; if you contrast the very sophisticated tools available to deal with social concerns in highway planning with those that are used for route selection for rail passenger service, for instance, you'll find that they're very uneven indeed.

At the policy level, I think they are virtually nonexistent. I don't think, for example, that our friends at the Federal Energy Administration can tell us what it's worth to save a million or a billion barrels of petroleum above and beyond the market value. For another example, I think the ability to measure and to trade off against other costs and benefits the large-scale environmental effects resulting from, say, a large-scale diversion to intermodal freight shipments is pretty skimpy. I don't think we're condemned to muddle-headedness, to use Judith's word, but I think one effect of this inability to analytically incorporate social concerns is that transportation policy formulation, if it ever was not, is essentially a political process. I mean political in the best sense. It's the process that we have of making those very difficult trade-offs between conflicting goals with inadequate information.

Politicians do, however, need facts and analyses, even if the most difficult part of their job is necessarily intuitive. And those concerned with the formulation of policy recommendations had better be sensitive to those needs. The Congress needs to know, for instance, the practical significance in quantitative terms, of environmental and other social effects. They need it in a form that they and their staffs can assess and understand, not as the last page of a pile of computer output. And they need it from a source they can trust, unadorned with blatant self-interest or ideological fervor. And this last, I think, is an area where many of us, both on the industry side and in the executive branch, and specifically DOT, have lost some opportunity to affect legislative policy. Even some academics get identified with a position in sort of an ideological way.

If Congress' needs for analysis and information regarding social effects of transportation policy decisions are not met, I think we'll suffer with bad policy decisions or perhaps, more likely, no policy decisions. Because while congressmen make speeches, I think they're too smart to base decisions on rhetoric, even their own.

A specialist in transportation systems, energy policy, and operations research, Mr. O'Donahoe has directed major transportation studies for the Senate Commerce Committee and the U.S. Railway Association.

DISCUSSION PANEL

"ISSUES FACING TRANSPORTATION AND OPPORTUNITIES IMPLICIT FOR TECHNOLOGY – FROM A SOCIETAL VIEWPOINT"

Remarks by
Carl S. Rappaport
Director, Conservation Policy Office
Federal Energy Administration

I find it very instructive that nearly every speaker so far has mentioned energy or FEA or sometimes both, and I'm not quite certain whether this is because of my presence on the program, or despite it. But in any event, I would contrast this situation with what might have taken place at a conference like this only three and a half short years ago, prior to the time of the Arab oil embargo, when I suspect that energy would hardly have been mentioned. I think we've come a long way. Whether the effect of energy is "moderate" or "substantial," I think is less important than the fact that it's significant. It's more than minimal. And this is an important example of a kind of fundamental change that Ms. Connor was talking about.

I would say, also, that energy conservation is not, in any sense, a "muddle-minded," "emotional," "irrational," or "confused" issue. Since energy is a major input factor in many industries, it is rational to consider it as an economic factor. In other words, energy-intensive industries, of which transportation is one, are bound to continue to pay increasing attention to opportunities for energy conservation in what they do. This does not require any repeal of the laws of economics, physics, or logic, but is rather a manifestation of the application of those laws.

In the same way, energy considerations need not be "layered on top" of actions that were based in the first instance on other factors, but are considered increasingly in the ongoing, mainline, decision-making process. In a similar kind of fashion, it seems to me that physical surroundings do not necessarily determine values which in turn create basic institutions and processes in response to the values. It seems to me that this is putting the cart before the horse, or perhaps in a more technological way, putting the cart before the engine. In a very real sense, I think, in the future, technological progress is going to be influenced and in large part determined by the kinds of values we want to sustain or support, the kinds of future trends that we would like to encourage and facilitate. In the same way, the changes in values that are occurring are not primarily based upon technological development. It seems to me that the kinds of acceptable levels of employment, growth, and welfare, to use the quote from Dr. Heilbrouer, have much more to do with societal aspirations than technology.

Concerning the reference to a downtown people-mover, it seems to me that this is not in any sense an academic kind of issue. We actually built, after all, a personal rapid transit system by designing the guideway before we designed the vehicle – before we designed the software – and put it all in an area that taught us nothing about demand, about socioeconomic impacts, about income redistribution effects, or about aesthetic intrusion. That's hardly a way to go about an RD&D program in the technological field.

Reference has been made to the 3-M Company. 3-M is also a leader, as I'm sure many of you know, in energy conservation in buildings (both lighting and heating), in industrial processes, and in transportation through a very successful and very effective employee vanpooling program. I can assure you that 3-M is not muddle-minded, emotional, irrational, or confused on this. It is a rational economic decision to go this route, and I suspect that's equally true, at least in the longer run, of pollution control.

I think I'm a bit more optimistic about the future of the railroad industry than a few of the previous speakers have indicated. It seems to me though perhaps that one's standard of reference needs to be a bit more limited in the sense that just stopping the downward trend in the railroad industry would be a major accomplishment. In these terms, I think the railroads, as an energy-efficient mode, are going to play a major role in the freight transportation sector in the future. It will be a major issue for public policy to determine how to restructure the capital investment in the railroad industry so as to serve the most appropriate markets and the most appropriate commodities.

In the same way, railroad electrification makes a lot of sense in energy efficiency terms, both as a gross conservation measure and because it allows us to divert from diesel fuel to coal, which in itself is a desirable public policy.

The issue of freight distribution centers was mentioned. I would like to say a few things about that because I think it's symptomatic of a lot of other considerations. I think the obstacles to freight distribution centers have been primarily institutional, behavioral, and attitudinal – and not technological. It seems to me that's equally true of a lot of the kinds of improvements that might be made and have been proposed in the transportation

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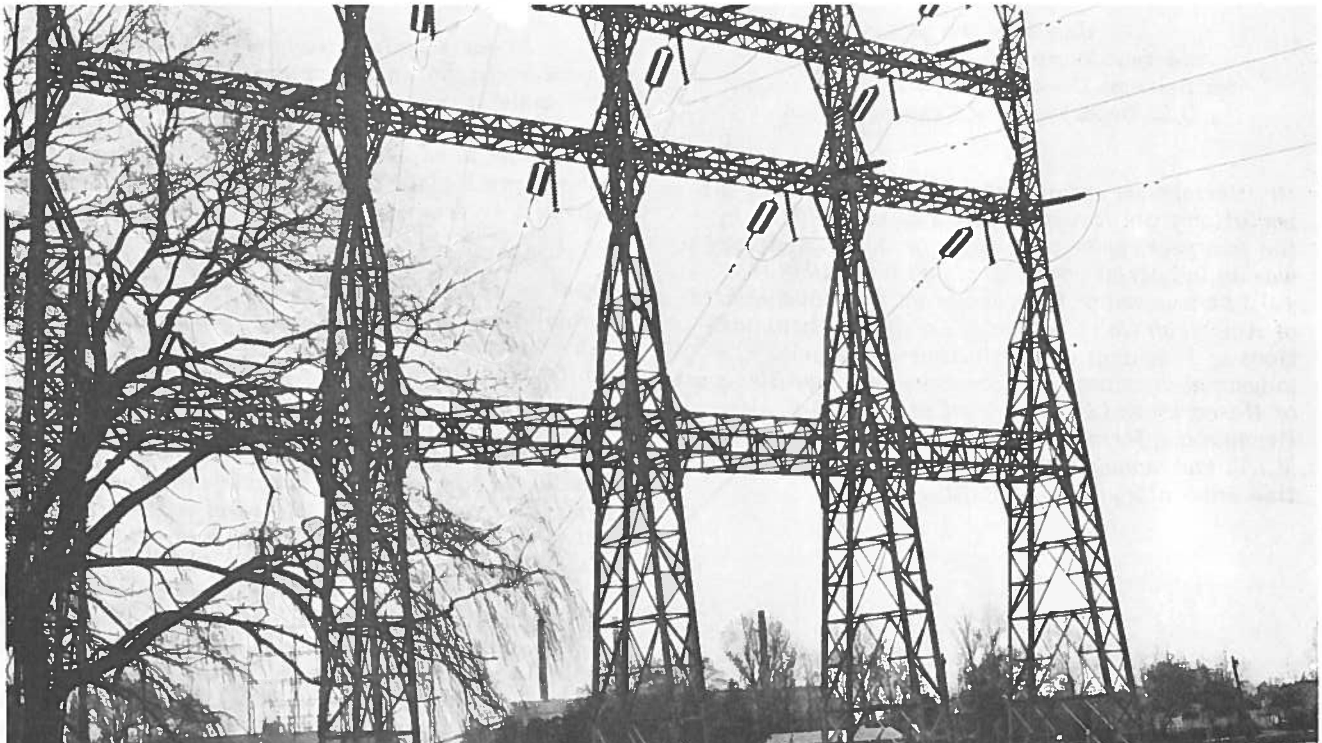
Before his present position, Mr. Rappaport directed FEA's Office of Transportation Research Policy. He has also worked for the Department of Transportation as a transportation systems analyst. In recent years he has been active in the field of transportation energy conservation.

field. I think that there will be increasingly in the future a demand for incremental technological improvements, rather than brand-new panacea types of technological developments. I would remind you that it was a defect in one small part that led to the northeastern electrical blackout a while back, and similarly in the case of the Apollo fire. There are many opportunities in the fields of command and control, management information, security, and safety where incremental technological improvements to make the existing infrastructure a bit more effective and efficient will have important roles to play.

Finally, the area of air cargo. As an energy-intensive mode, I think there is an ultimately self-limiting potential for air cargo, although I think it's important to look at the entire distribution system, warehousing inventory as well as just transportation, in determining the appropriate market for air cargo in the future. It does have a role, clearly, for high-value, low-weight goods, or perishable, high-value goods. But it seems to me that it is unlikely to make a major dent in the freight transportation system of the future.



Hamilton Herman
Assistant Secretary of Transportation
for Systems Development and Technology
U.S. Department of Transportation

Mr. Herman served as assistant secretary of transportation from November 1975 to early 1977. In the two years prior to joining the department he was an industrial consultant, and from 1968 to 1973 he was senior Vice President for Development of American Can Company. Earlier, he held positions of President of North American Rockwell's industrial divisions and Vice President and Director of Research and Development at AMF, Inc. Mr. Herman is a former assistant to the President of M.I.T. and manager of the Institute's Instrumentation Laboratory Flight Facility.

LUNCHEON ADDRESS

"CAPITALIZING ON TECHNOLOGY IN FREIGHT MOVEMENT"

According to the newspaper last Sunday they have now found skeletons which indicate that man has been around about 500,000 years. However, I would like to have you go back only about 200 years and consider the following possible scenario.

An inventor walks in to a prominent financier's office in London and says: "I've a great invention here! All I need to earn gains which Ben Jonson once described as 'beyond the dreams of avarice' is a small amount of money to finish my development.

"The way things are now if you want to correspond with your agent in Williamsburg in the New World you have to write your message out on a piece of parchment. You put it in an envelope. You hand the envelope to a small boy. The small boy goes down to the dock and hands the envelope to the captain of a sailing ship. The ship sails to the New World. The captain gives the envelope to another small boy who delivers it to your associate.

"Your associate reads the letter. He writes an answer out on another piece of parchment, which he seals in the envelope. He gives it to another small boy, who gives it to another ship's captain, who sails it on another ship back to London where the captain gives it to still another small boy who gives it to you. All of this has taken three months.

"But now, with my great communication device which I have here in this black box and which I call a radio, it is only necessary to talk into this marvelous instrument and instantly it transmits the words across the ocean to an associate who has a somewhat similar black box, which is called a receiver. The associate can immediately hear my words, he then replies through his own radio. So in a matter of minutes rather than months you have your answer. All I need is a small amount of money to complete this development."

The financier says to the inventor: "Are you telling me your radio puts out some kind of sound which goes up into the air mingling with the countless other sounds that are already there . . . like the cry of the seagulls over the Thames? [sound of seagulls] And the roar of lions in Africa? [sound of lions roaring] Or the music of bands in the Caribbean?" [Caribbean music]

"That's right," the inventor says.

"And then," the financier continues, "you mean to tell me that your sound travels mysteriously and instantaneously 3,000 miles to the New World where it mingles with the sounds of waves breaking on the rocky shore, the growling of bears, the whooping of Indians, and the cry of still more sea gulls?"

"That's right," the inventor insists.

"Sorry my friend," the financier replies. "Your invention is out of line. I suggest that you stop in a place on the other side of the city on Knightsbridge Road. It's called Bedlam. Check with the financial officer."

Now, some years later, another inventor walks into another financial office, and says: "I have a marvelous invention here. I call it an internal combustion engine and it will one day replace much human travail and the horse as well.

"It works like this: Into this chamber I drop a small amount of liquid called gasoline. I touch it off with a match. It explodes driving this piston down, which turns this thing I call a crank, which can turn a lot of things . . . say the wheels on a wagon.

"My technical problem was to get enough work out of this device and so it was necessary to drop some 1,700 drops of this product called gasoline into the cyclinder and light the mixture 1,700 times a minute. I've solved this problem. This device will power wagons and many other wonderful transportation devices. [sound of steam locomotive] Along with the steam engine it will revolutionize transportation. Now, all I need is a small amount of money to build a prototype."

The financier replies: "Sorry, my good man, we're putting all of our money into the rope business at the moment since the market forecast for the growth of commerce shows that there will undoubtedly be a need for vast numbers of new sailing ships, all of which will require miles and miles of rope!"

Well, one day still another inventor comes into an office in New York. "See here," he says, "I have a great invention. I call it an airplane. It will revolutionize travel. Sailing ships will die; steam ships will be driven from the seas. Long distance travel will be almost entirely by my device. Now, if you want to go from New York to Buffalo it will take you 20 days to walk but with my device you will be able to do it in one hour.

"Here is how it works: This part I call a wing, which has attached to it powerful engines. These engines suck in a vast quantity of air in the front and blow the air out the back. This drives the wing forward with great rapidity. I tip it up slightly and shazam!! The whole thing is airborne. [sound of wind rushing past] Passengers ride in the middle section which is called the cabin.

"Think of what this will mean to transportation and human communication! A revolution, I tell you! Steam ships and trunks are on their way out."

The New York financier responds by saying, "Sorry, my friend. Your idea was once dreamed up by a fellow by the name of Icarus. He's gone now, but you may well catch up to him!"

But our friend was not all that nutty. We have the radio. We have the internal combustion engine. We have the automobile. We have the airplane. We have the revolutions.

Is this the end of the line? We think not, but now we have other credibility problems. You want to ship something by rail from Washington to Boston. You ask the railroad how long it will take and when it will arrive. The freight agent maybe tells you it will take about 10 days. It will arrive maybe on Tuesday. But if not on Tuesday, maybe on Wednesday or maybe even Monday. The odds are six out of 10 that that will be it. Now if the odds fall out wrong, say on the four out of 10 side, you may not see the shipment until maybe Thursday or Friday, if then. In view of this fact, the airplane will give arrival times within five minutes with 98 percent confidence, not five days. A trucker will give you one day with 90 percent confidence. Do we believe the rail freight performance is correct or could we somehow be going backwards.

If we look at a photograph of a current freight yard do we believe that this is the end of technology; that this is all we are going to see, give or take a few product improvements such as improved humping or automation?

If we have a look at the garment center in New York do we believe that this is the pattern for moving urban goods tomorrow – the only technical answer?

What if we go back and have a look at the mail. You used to write out a letter, then give it to somebody (perhaps not a sailing ship), and he walked to where it was supposed to go and gave it to the person that you sent it to. But then we got bright and we put him on a horse and he trotted over there. Ah, this was a revolution. And then he got even brighter and came up with a relay – the pony express – and he saved some more time. Then came the product improvement engineer and he said that the horse eats wheat and we may run out of wheat. And the horse gets tired, so we will have a mechanical horse. We will study ride quality, weight distribution, hydraulics, knee actions, and stiffness.

We could have continued our product improvement program naturally down that line, but we didn't. With the invention of the internal combustion engine we then invented the automobile and the truck and the horse was gone. We didn't do it the old way any more. In the rail area we have not entirely stood still. We do have containerization, which has been a help. We do have trailer on flat cars. We do have more automation in the freight yards. We are working on the freight car identification codes so that we can keep track of and improve the utilization of freight cars. But we are plagued by heavy capital expense and the low utilization of our investment as this chart shows. Only 8 percent of the time does the freight car move with payload.

In this day of high interest rates and heavy capital expense in the rail area, utilization of this type simply cannot be in the long run. We must have greater productivity to generate adequate profits to provide for change. But when we try to speed up the trains, perhaps to improve our turnaround time and improve the weight capacity of the vehicle, suddenly we find that either our guideway or railway has deteriorated due to the heavy weights and the high speeds or it has deteriorated because we just didn't put in enough maintenance money and the cars derail on poor structure.

So we study fracture mechanics. We look to see why rails are cracked. We develop automated inspection cars for going up and down the tracks to see whether they are lined up properly and leveled. We put in a test center out in Pueblo and do some very good work on rapid testing of new developments in rail equipment. But most of these are product improvements.

At the Dallas/Ft. Worth Airport we experiment with automatic shuttle operations which will move people on the one hand and goods on the other hand on the same line. We ask ourselves whether this automated system isn't the predecessor of some future automatic system which will handle both people and goods in urban areas. We see that our containerization development can be a truly intermodal package moving from truck to rail and rail to ship. We develop and utilize pipelines especially for movement of liquids and gases. We have developed and used a wide variety of trucks for moving freight and other work. We have gone to larger and larger trucks and now have considered even larger trucks which could require rebuilding some of our interstate highways. But even in the truck area as in rail we find ourselves with institutional barriers which seriously inhibit efficiency. The double trailers cannot go through all states. There are other state regulations on weight and type of truck which vary between states and therefore require loading changes at state borders or call for special kinds of trucks.

Now we look at these necessary product improvement possibilities . . . we look to see where we are now, and we look at the past and present potential of technology. We have to ask ourselves if we believe that we cannot have better freight terminals for much improved handling of freight within a mode but especially also between modes such as rail and truck.

Do we believe that we cannot have "freightways" of tomorrow that will move intercity goods much faster more flexibly and more efficiently. Do we believe that we cannot have much more efficient urban goods movements including automatic systems handling both people and goods. Do we believe that we will always lack the political courage to require proper scheduling of loading and unloading operations in the urban areas at night or on other off-hours – and the political and management courage to change our regulations and operating systems to meet the needs of today and tomorrow? Do we believe that we cannot have better flow control systems which will permit more optimum flow of freight and vehicles throughout our distribution network; that we cannot and will not develop much better automatic warehousing and material transfer systems; that, indeed, adequate future mobility of people and freight calls only for more and more highways swarming with jillions of dinky cars and rubber-tired trains?

If we believe that we can have the better freight terminals – the "freight ways" of tomorrow, the more efficient urban goods movement, the courage to change our regulations and to provide the incentives for private industry to improve our transportation system – if we believe that these things are possible, then this picture is the picture of a transportation sunrise. But if we believe that we will always lack the courage to accept change and to provide the incentives for constructive change – that we will indeed fill up our highways with more dinky automobiles and rubber-tired trains, that we will not use technology in the future as we have in the past – then this picture is unfortunately the picture of the sunset of transportation.

I personally believe it could be a sunrise, but that is by no means certain unless we step up to the requirement for change . . . for better incentives in the transportation sector and the constructive use of our substantial technological potential to serve our human needs.

DISCUSSION PANEL

"PROJECTED TECHNOLOGICAL RESPONSES TO PROBLEMS AND CHALLENGES BY VARIOUS MODES"

Introduction to Panel by
Charles D. Baker
Chairman
Harbridge House, Inc.

We have heard of a number of things this morning. There seems to be some common agreement that there may be large opportunities in the railroad industry. But, indeed, there are an enormous number of problems. . . .

Ham Herman very eloquently laid before us a big challenge. He said we have an opportunity to view a sunrise or a sunset. Take our pick, but it's up to us – and I think that's what this conference is all about. Certainly, also this morning we heard from Judith and her panelists, who underscored the fact that not only has technology lost some of its credibility, some of its glitter, but indeed we have a whole new sense of values in the process of doing things, which is significantly important. Therefore, it's perhaps quite appropriate at this juncture that we turn to five gentlemen who have the problem of bringing the new technology onstream.

We have John Ingram, premier gentleman from the choo-choo game. We have Joe Healy, who is going to tell you Flying Tiger and air cargo are here to stay. Tracy Park is going to tell you that the pipeline business is good stuff. Jake Hershey is going to have quite a lot to say about the barge line, and of course Bill White will tell you that concerning all those nice things people were saying about truckers, if anything they were understated and of course they're all true.

With that introduction, I think we will start off and ask Joe Healy, the Executive Vice President of Flying Tiger, to stand up and give us 10 or 15 minutes on what in fact is really going on in air cargo, and specifically what is Flying Tiger doing with respect to a number of the kinds of issues and questions we've heard earlier this morning.

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Question (addressed to Mr. Baker after panel discussion): Mr. Barnum is for deregulation and free enterprise. Mr. Meyer forecasts a free enterprise future. Maybe you should inject into this conference the question of national need and objectives (for example, defense and P.K. Carlton's problem) and whether or not federal control and support to some degree is appropriate to further national objectives.

Answer: General Carlton of the Military Airlift Command believes that national security requires a development of a large cargo capable new generation of aircraft. He is also of the mind that, if developed solely for the military, the expense will be substantial and perhaps exorbitant, but that it should be possible to develop this jointly with industry for commercial application. Underlying this premise is the notion of some federal participation in development and perhaps procurement. Such participation being financial.

The federal government has involved itself historically all over the place in free enterprise situations, and I think on balance favorably. Contrary to conventional wisdom/garbage, the interstate system is a free enterprise exercise paid for as a virtually cash transaction by the people who buy the interstate system (use it). It is done by various taxes levied on automobiles and trucks. This money, in turn, goes back in terms of the product that they use – the highway system. What the federal government does is play a brokerage role, recognizing that if a myriad number of individual highway contractors and highway engineers tried to somehow or other get together with a myriad number of automobile and truck drivers, the game would never get off the ground.

Going a step further, we find that the entire SST program (which was not canceled because it was anti-free enterprise, but rather was curtailed because of some environmental and "priority" concerns) was an example of federal financial participation in getting launched to private market exercise. Certainly the Corps of Engineers Inland Waterway projects represent federal participation in what is a private activity – the bargeline industry.

The Airport-Airways Trust Fund was structured to be private-sector user self-sustaining, except for the "20 percent military share." This was the part of the system that was presumed to be used by the Air Force for national security reasons, and thus an appropriate charge from general rather than user tax revenues.

I find nothing inconsistent with federal participation facilitation and cooperation with free enterprise activities.

DISCUSSION PANEL

"PROJECTED TECHNOLOGICAL RESPONSES TO PROBLEMS AND CHALLENGES BY VARIOUS MODES"

Remarks by
Joseph Healy
Executive Vice President
Flying Tiger Line, Inc.

Admittedly, like many of the previous speakers, I came here with a very well prepared text. A text that may not fit. The moderator warned me in his letter, "Don't be too concerned about your prepared text. You'll hear enough in the morning session to talk for 15 minutes in the afternoon session."

Let's start by asking a question. "What really stimulates advances in technology?" I must admit to you (probably as an amateur) that I was thoroughly impressed when President John F. Kennedy said to the nation, "We have this day embarked on a program to put a man on the moon." I was impressed with the fact that obviously before he made this statement he clearly defined the objective and he really understood, or hopefully understood, the needs of the people. In my opinion he did, for if he failed he faced the problem of convincing Congress to approve his program. He felt confident that conceptually it was feasible; no one could prove him wrong. Of the greatest importance, he had some realistic idea of what it would cost. Certainly this process of decision-making should be followed by transportation executives.

As space challenged the '60's, we as leaders of the transportation industry should accept the challenge of the '80's and immediately deal with the world demand for a more effective transportation system. It remains a stagnated challenge of this decade, for we have been unable to apply the resources available to us to reach the heart of the issues and vigorously deal with them.

Certainly, no one today can engage in tangible courses of action in this environment of distrust. Everyone unfortunately exists in an age of "load-and-fire" communications. We constantly investigate each other and are quick to sue each other. We also attempt to resolve these issues in a quasi-judicial arena of the regulatory process. However, I hasten to tell you that, despite what you heard this morning, the domestic freight rate investigation has been concluded. It is being implemented without a formal decision. Indeed, it remains a very unique regulatory process. No irony exists, therefore, that we reach an impasse in trying to adequately determine what everyone means by deregulation, more regulation and regulatory reform. Just consider the ineffectiveness of the laborious legislative process in trying to focus on the real problem.

As I flew here today, I asked myself will this forum herald the start of an ongoing dialogue which has its emphasis on listening and understanding? This Transportation Center most certainly possesses the vast resources and the charter to encourage an ongoing dialogue between all of us. Its staff most assuredly has the capability for essential feedback. They can evaluate all of the recommendations, test the most promising ones, and bring to our attention those which will stimulate the rapid development of a more effective transportation system. To me, this is one way of breaking the rhetoric and advancing toward a viable solution. Otherwise, we will remain a group of people repeatedly talking to ourselves about the same issues, without reaching tangible results.

I think we have to ask ourselves a few questions. Do we really know what the public wants and needs? Who can best represent the interests of the public? What are the service characteristics that are responsive to these needs? How can these services be segmented to achieve the delicate balance between a competitiveness which John Barnum spoke of this morning and the prudent employment of our national resources? How can these services effectively and efficiently respond to the needs of small business as well as big business? Where is the voice of small business? I think so far we have only heard the voice of the big buyer. And yet where is the voice of small business, who, in my opinion, tends to subsidize these volume rate structures.

Standing here today, I can vividly see that research, on the demand side, is the answer. And it may well be the only answer. We need research that goes beyond the testimonials which articulate the wants, theories, and desires of those who testified. Research that goes beyond the simplistic quantitative marketing techniques employed thus far in the decision-making process. The Department of Transportation should recognize the need for effective research programs that challenge the professionals of this center . . . be they planners, economists, or psychologists. In my opinion, the cornerstone for success is new knowledge; fresh insight which speaks to the question of what are the real needs of the public.

Mr. Healy, who began his career with Flying Tiger Line in 1948 as a cargo handler, was honored by the Airfreight Motor Carriers Conference as "Airfreight Man of the Year" for 1973.

What are the risks of pursuing the "do-nothing" alternative? If we take a back seat approach instead of instituting effective research programs and developing solutions to meet the demands of the public, next time we meet we'll find ourselves in a catastrophic problem equal to the dilemma the public now faces with our present-day postal service.

I offer for your consideration that the major segment of the public has already expressed an opinion and its position in this controversial debate: what does the public need, improved postal service or lower rates? They have reached a decision and have turned to alternate services responsive to their immediate needs at considerably higher cost. Let me deviate for a minute and remind you that Federal Express, who certainly has gained your attention in recent years, has successfully marketed a $13 postal stamp. Ironically, postal authorities now plead with other government officials to rule some of these alternative services illegal in order to force the traffic back into the postal system to minimize its losses. To me, there is something fundamentally wrong with this approach.

Up to this point, I have somewhat departed from the subject at hand, technology, for I truly believe the environment must be positive in order to achieve significant technological breakthroughs. Unless we set forth some definitive guidelines, we will be unable to agree on the priorities and will be incapable of prudently deploying our resources. As you will recall, I am in the airfreight transportation industry, and we are certainly a good case in point. I am sure you have heard the comment many times. If our industry leaders were only innovative, we would have it within our power to be cost-competitive with the truck. And others, far fewer in number, are even brave enough to allege that the aircraft could be cost-competitive with the train. They can lead you down a number of blind alleys with such answers as improved containerization, complete intermodality, improved aircraft design, or even lower pilot salaries.

As each of us knows, the real answer cannot come from fragmented analytical processes, but only from a comprehensive analysis of the total service demand coupled with a thorough examination of the total economic structure. Today, the most efficient airfreight carriers have, for example, a total cost of 27 cents per ton-mile. Giving the innovator the benefit of the doubt and, for the moment, disregarding the public service responsibilities and the forces of labor, a new system could operate at a 15 to 20 percent lower cost compared with current levels. Let us attack it from a different direction and consider the fact that just the cost of capital to finance even the most innovative idea plus the fuel costs already placed on us force us out of the competitive ball game. These costs alone total 13.7 cents per ton-mile, compared to the truck yield of 9.7 cents and the rail of 2.1 cents per ton-mile.

I was delighted to hear people say this morning that, if you are waiting for the air cargo breakthrough, it has already occurred. For a moment, let us also deal with this myth called the half-empty airplane. I just returned from Asia. Sears & Roebuck has a critical problem. No airfreight space to meet their product demand. They criticized us for poor management planning. I candidly responded that if they wanted to take on a task of trying to rearrange the holiday periods of the world to optimize transportation modes, good luck. Some transportation experts also campaign to force airfreight into the bellies regardless of the market requirement. It will not happen as long as there is a better service alternative. Frankly, as long as we are breathing, we intend to provide that alternative. However, a percentage of belly service does have value. An underutilized resource, the combination carriers know how to market that product effectively and accomplish their mission.

I was extremely pleased to hear people focusing on the subject of capital cost. The one thing that has always been missing in these sophisticated economic research papers is the capital cost element. In our business, that is a major piece, if not the most critical piece. We were encouraged to note in a recent NASA document this fact was clearly articulated.

As you can readily see, airfreight is definitely not cost-competitive. Instead, we are a unique and time-alternative transportation system. We have found, after completing an independent 18-month study, that four out of five air cargo users are not totally interested in price. Granted, they consider it, but that is not the critical issue. The critical factor is improved service and increased frequencies. They point out that air cargo service today is deteriorating, and it is definitely not meeting the shipping public's demands.

At this point, I can conclude that, without well-defined guidelines and objectives, we cannot prudently direct our system planners or our engineers to focus their attention on the technological opportunities for improved productivity. One thing is now certain: you are not going to take my word for it. You must prove it to yourselves.

A second challenge must revolve around a partnership for the 1985 freighter. Yes, a partnership. A partnership that must go beyond this industry, since the public demand cannot generate the number of aircraft required for an airfreighter development program solely for commercial use. I have been advised that the minimum number of aircraft required is 200 plus before we could attain an economical level that would encourage development and eventual production. We seem to have two choices. First, the freighter must be an adaptation of the passenger aircraft, which, I remind you, has served us well in the past. Bear in mind that the 747 was initially designed as a freighter aircraft. This defeats one myth that freighter aircraft are always derivative of passenger aircraft. Our second choice is the military cargo aircraft development program. Unfortunately, our history of success in pursuing this joint venture has not been impressive. Let's consider the C-130 and its L-100 cargo counterpart, the C-141 and its L-300 commercial model, and the controversial C-5A and its L-500 commercial equivalent. Let me assure you that the potential for success is still extremely viable, and we are encouraged once again to explore joint development programs as the government proceeds with its current CXX program, commonly known as the airfreighter of the 1980's.

As we focus on the freighter aircraft itself, we must place major emphasis on exploration of improved propulsion systems . . . from an environmental standpoint as well as an energy standpoint. First things first. We must decide what the fuel will be. In this particular case, I am worried more about the supply of fuel once it's chosen. We must seriously think about this. We are projecting a 30-year development program, when you consider 10 years of development and 20 years of depreciation of this equipment. We are projecting through the year 2005. All of our answers so far seem to fall back on fossil fuel as our only alternative. However, our supply may be dependent on the majority of other users finding alternative sources. Or, to put it in a different light, our success is predicated upon the development of new fuel sources for industries and businesses throughout the world which, ironically, are depending upon us essentially for the transporting of their products.

I was also going to address, in some detail, airfreight technology and its impact on productivity. However, I will take this opportunity of bypassing the subject, since I am not really technically oriented. Let me tell you that unpressurized cabins are not an answer from a marketing flexibility standpoint; loss of this flexibility clearly outweighs the operational gains.

Perhaps another great challenge that does warrant our immediate attention is on the ground. While the airfreight ground environment today represents only 17 percent of the total revenue, nevertheless we can immediately undertake major steps to improve service and reduce cost. Our order processing system, for instance, needs in-depth examination and the introduction of advanced technological equipment and systems. The paperwork generated between the user, the carrier, its agent, bankers, customs, and insurance companies represents a significant cost impact of considerable magnitude. It probably will not astound you when I report that 20 percent of the time in transit is spent in the air flying the goods, while the remainder is spent on the ground tied up in the paperwork and procedural bottlenecks. To date, the airfreight industry has allocated several hundred million dollars in mechanizing these bottlenecks and comparatively few dollars aimed at eliminating them. Let us call upon the United States Government, coordinating with all the parties in the distribution channel, to set a leadership example that goes beyond the traditional band-aid treatment they have advocated to date.

In conclusion, I can readily call to mind the recent comments of our moderator today when he said in a recent speech, "Is technology going to do something dramatic in the field of airfreight transportation? I simply don't know." He accurately pointed out that, in general, we are an industry in search of an identity. We are still trying to decide if we are an incremental business, a backup business, or a supplemental business.

We at Flying Tiger see a very positive and vital role for airfreight transportation. It is a supplemental business. However, we must be seen as an integral part of our overall national distribution system, and not something unto ourselves. It is a time alternative as well as a great marketing tool. Airfreight quickly fulfills the urgency-emergency needs that will be ever-present in a changing world. A world that has great difficulty managing change. And, therefore, like the space program, we can attain the transportation challenge of the ensuing decade through a systematic analysis of user needs, a service definition that is responsive to the public needs, and through a determination of the price that must be charged to generate profits required to attract future capital. Then, and only then, will we establish the guidelines and create the environment for the technological advances required for improved productivity in our national distribution system.

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Question: From the carrier viewpoint, what are the problems associated with the adoption of a "standardized intermodal through bill of lading," which would incorporate the characteristics of both the bills of lading currently in use and the various waybills, freightbills, and so forth, used by each mode? Can you foresee this development in the future?

Answer: Flying Tiger Line, Inc., has been an advocate of this documentation simplification procedure, both nationally as well as internationally, through our work in the Transportation Data Coordinating Committee. I feel the potential for achieving success in U.S. commerce is very high. After five years of work with the National Committee on International Trade Documentation and the IATA CART program we have made some progress, but considering the entire scope of the program our progress is extremely marginal. At best the program will be developed on a bilateral agreement basis – country by country. In total, the United States must take a stronger leadership role.

DISCUSSION PANEL

"PROJECTED TECHNOLOGICAL RESPONSES TO PROBLEMS AND CHALLENGES BY VARIOUS MODES"

Remarks by
William G. White
Chairman
Consolidated Freightways, Inc.

Like so many of the other speakers I approach this with some trepidation and some wonderment. I'm wondering why I am here. I heard some things this morning that I agreed with, and some that I don't agree with. I think maybe I'm here because I am curious as to what this transportation center is doing, what they are proposing to do . . . and hopefully maybe what they are not going to do to us [laughter].

It reminds me of a story. Out where I live in northern California there was a group of sportsmen last year who got together and chartered a plane every Friday and flew over to Reno. They went out hunting and fishing and would come back Sunday night. One of the group had a girlfriend in Sacramento, so they used to drop him off on the way over to Reno. On Sunday night they would pick the man up at Sacramento, give him a few fish, tell him some stories and he would go home with the rest of them. Well, along toward the end of the season, about late November, they got fogged in at Reno, and of course there was no fog at all in Sacramento. This poor fellow was wandering all over at Sacramento Airport at wits' end. Four or five hours later their little plane finally showed up on the strip there. The man ran out to meet them, grabbed them and said: "God, am I glad to see you. You know, I was afraid you'd crashed without me."

So, anyway, my appearance here may be in that same tenor. I don't really want you to go down without me.

I would like to comment on some of the remarks that were made this morning. First of all, practically every speaker spoke about intermodal operations, and Dr. Meyer spoke also about speeches that he had made and how he had come to realize that some of the things he had said had not actually transpired. I think maybe this is my position in regard to intermodal transportation because I can produce, I think, at least a dozen speeches that I've made about the glories of intermodal transportation, and how it's the transportation of the future. I have to confess today that my company has been in and out of intermodal transportation almost of every kind you could think of – truck-ship, rail-truck, piggy back and truck-and-air – and today we're not engaging in any intermodal transportation. Maybe you would be interested in knowing what happened to some of these.

We were one of the original carriers into Alaska using truck and steamship; this was over 20 years ago. We had a very large container operation. We owned the containers, we moved the containers on the highway to Seattle, and we had a partner in the steamship business that handed them to Whittier, primarily, on the Alaskan peninsula. We distributed them throughout Alaska, where we had a sizable truck operation. Well, we got out of that business when a competitor came along with bigger and faster ships and our partner (the ship line) didn't want to meet that competition. We don't want to try to stay in a business unless we are competitive – so we got out.

Ten years ago, or rather I should say more than that, 15 years ago, in the early 60's, we were probably the largest piggyback user among the common carriers. But gradually we found that we had to get out of the piggyback business because of the lack of competitiveness of the service that we were able to give using piggyback service as compared to the motor carriers that were operating over the highway.

Truck-air . . . we had at one time joint rates with two major international air carriers. We finally came to the conclusion that the airlines were not really interested in the business. They would take the business that we developed and would handle it, but they would not go out and try to develop this type of business themselves. So we got out of that business.

I might also say that we don't feel any pressure from shippers to provide intermodal rates, handle intermodal shipments, or give intermodal service. Most of the pressure seems to come from economists and college professors [laughter]. I think we're more or less inclined to let somebody else handle their traffic [laughter].

Mrs. Connor spoke this morning about the central city freight distribution centers. I think she made a prediction that it probably wasn't going to happen. I can tell you that 20 years ago the New York Port Authority had the same idea and set up such central city freight distribution centers – one in Manhattan and the other in Newark, New Jersey. I can tell you that they were failures – and we were a company that used both of them. They didn't fail because of the reason Mrs. Connor seemed to predict. They failed because of the lack of ability to give service through those centers. They turned

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Mr. White began his career in the trucking industry in 1960 with Consolidated Freightways after 25 successful years of railroading. He is a recipient of Syracuse University's Salzburg Memorial Medal for distinguished service in the field of transportation.

out to be just another point where freight was delayed; it resulted in our going back to our own terminals. Before we try more programs like that we had better look at those that already have been tried, and failed, to see whether or not the new ones offer any better hope for success.

There has been a lot of talk about fuel, and energy, and I can tell you that the trucking industry, like all other businesses, is concerned about these problems. I think I ought to give you some figures about my own company. First of all, we've had some talk about empty cars, empty freight cars, empty airplanes. And I'm sure that all of you have seen figures that people throw around about empty trucks. Well, for my own company only 6.5 percent of our mileage is empty mileage. This is because we try to operate a balanced operation, and we do everything we possibly can to achieve that balance.

Secondly, and that this will bear out what Dr. Meyer said this morning, between the various carriers there probably is going to be very little change in tonnage moved by the various modes, in spite of a further fuel increase. In the case of my own company, fuel costs are 6.6 percent of our cost. Now when you consider that labor is 60.6 percent of our cost, you can see that an increase of 10 percent in our fuel cost is not going to be nearly as important as the contract that we signed with the Teamsters Union last March.

We are now using radial tires and wind deflectors, and we're making aerodynamic changes in our equipment. Engine manufacturers are helping by giving us better engines so far as fuel usage is concerned.

I think I should also give you this information about my own company. This year we increased our fuel mileage from 4.1 miles/gallon to 4.3 miles/gallon. Now that sounds pretty insignificant, but in the case of Consolidated Freightways that means a saving in fuel costs of 1.5 million dollars a year. So we are making some progress there.

I might also say that we heartily endorse the 55 mph speed limit. Most major companies, including my own, have sizable fleets of unmarked cars, some of which we recently equipped with radar, to assist the state police in enforcing the speed limit so far as our own trucks are concerned.

In addition to energy-saving improvements to our equipment, the most important means of reducing fuel consumption and improving our productivity would be an increase in vehicle sizes and weights. Mr. Barnum and Dr. Meyer have already talked about this so I'm not going to discuss it at any length except to say that my company pioneered in the use of double trailer equipment. We have seen this go from a western type of equipment to nationwide usage. We have seen semi-trailers go from 35 feet to 45 feet. They still do not match, however, the cubic capacity you can achieve with two 28-foot trailers. I see a continuation of the spread of twin trailers usage and I believe that this equipment will eventually be permitted in every state in the union.

Mr. Herman at lunch pointed out the states that still do not allow double trailers. Generally speaking, all the states west of the Mississippi permit such usage; as a general statement, most of the southern and some of the eastern states do not. In the west we use triple trailers in a number of states. I can't see anything but a continued expansion of that development. The cost savings and benefits to the shipper with the use of larger, more efficient trailers is obvious. The benefits to the economy and greater productivity in the larger units is equally obvious.

I should emphasize that fuel consumption does not increase in proportion to the weight transported. A triple trailer combination, for example, can do 50 percent more work than a twin trailer combination on 18 percent more fuel. While I'm discouraged at times by the slow pace at which we move in increasing length and increasing the size of our equipment, I am optimistic that we will have more efficient equipment in the future.

There was some talk this morning about computer usage. I think that I should say that in my opinion one of the most important management tools developed in the last 15 years has been the computer. In our company the computer today is not only doing accounting functions, but also doing a tremendous amount of operations planning. Our equipment is entirely controlled by computers, which has improved our utilization of the fleet and has improved our service. We are now finally on the way to eliminating a lot of paperwork and people involved in the rating and billing process. I might say that this morning before the meeting I visited our Boston terminal which we built about 10 years ago. When we built this terminal we planned for an expansion of the office. Not only have we not expanded the office, but we actually have about a third of the people there that we had 10 years ago. So that plan for expansion has gone down the drain by the use of the computer and a reduction of paperwork.

Looking at power units of the future, I believe we will be using diesel for a long time to come. We have been running gas turbine engines in our fleet for over 10 years, but I'm still convinced that the statement I've made that we are going to be using diesels is still true. The reason is that gas turbines still do not approach the diesel insofar as fuel efficiency is concerned. Diesel manufacturers have found ways to improve their engine so far as air pollution is concerned, and so far as noise is concerned. We have been completely "dieselized" since World War II. We started dieselizing the city fleet in 1960; we backed off from that in 1970; and today we're committed to gasoline and LPG in our city fleets. Here in Boston is located one of the 13 complete fleets of LPG gas-powered vehicles.

Eventually I would expect to see computer technology replacing driver decision in determining optimum speed and power in our road equipment. Drivers will be in constant contact with headquarters. They are already now in constant contact with almost everybody [laughter]. The truck will be quieter, and more comfortable, as well as more durable. Radial tires and clutch vans will be standard, since they definitely decrease noise and improve fuel consumption. We now have city trucks in congested areas that are lighter and smaller, which save fuel; they are easier to load and unload; and they are more maneuverable. In the 80's we may see electric trucks for some of these same purposes.

City dispatchers already are using our computer to make match pick-ups with pick-up calls and match the pick-up trucks out on the road with pick-up calls. In fact, we've hardly scratched the surface as far as computer applications and benefits are concerned. The computer will automatically route all incoming shipments to the delivery truck. Our shops are advised today as to what service to perform on each arriving piece of equipment. Eventually we hope to get rid of freight bills entirely. I think somebody spoke this morning about the greasy piece of paper that goes with the vehicle. We think we can get rid of that piece of paper by use of the computer. By that time shippers and carriers will be interchanging data freely through a common software system. This is already within the state of the art, and may eventually create a much more efficient system of physical distribution.

There will also be a lot of smaller but important technological developments. For example, my company has been working for 10 years on finding a better way to check our tires. We now think we have the answer, and we're going to put some prototype installations on our property and see how they work in actual practice.

In summation, then, I see the next 25 years as exciting years in transportation and in the trucking industry. I don't agree with Mr. Herman. I think that in the next 20 years we are going to see more and more vehicles on our highways; we're going to see more and more highways; we're going to see more trucks on rubber tires running on concrete roads; and it's going to be a sunrise, instead of a sunset.

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Question: If you could operate your own trains over public right-of-way, would you go back to piggyback or rail container service?

Answer: While I doubt very much that there ever will be a situation where someone could operate their own trains over a public railway, my answer to the question is "no." The reason for this answer is because in my opinion even the best run railroad cannot compete service-wise with trucks running at 55 mph. over the system of highways as they are now developed in the United States.

Question: Given your background of years in railroading plus the trucking industry, would you give your views on the differences in management approaches between the two modes? Do trucking managers really do things better than railroad managers? How do trucks deal with the problem of shipment interchange (though it is a smaller problem than in railroads)? Is there anything in trucking which the railroads could use to improve their interchange problem?

Answer: The biggest difference, in my opinion, between the management of railroads and the management of trucking companies is the way they view the matter of service to the shipping public. No trucking company stays in business very long if it fails to give its customers service.

Railroad managers tend to become involved in legal problems, regulatory problems, tariff problems, operating problems, and so forth, and seldom do they ever try to to find out what their customers need in the shape of rail service.

Another big difference between the two modes and their managements is the flexibility the trucking manager has as compared to the railroad manager. The very fact that a truck line can go broke and disappear from the scene (some do it every year) makes the trucking executive much more alert to changes in traffic patterns and changing needs of his shippers.

Any railroad's biggest enemy is the other railroads they deal with. Each railroad tries to put the burden of delays and costs involved in the interchange of traffic on their connecting lines and this, naturally, results in a disaster situation insofar as the shippers are concerned. There is much more cooperation between truck lines than I ever found between railroads. Probably one of the reasons for this is that any short line carrier has a large number of motor carriers with whom he can interline freight; if he is going to stay in business very long as a short line carrier, he must find interline carriers who will give the necessary service on the freight he originates and terminates.

In the trucking business one seldom hears of customers' complaints because of delays in the interlining of traffic.

DISCUSSION PANEL

"PROJECTED TECHNOLOGICAL RESPONSES TO PROBLEMS AND CHALLENGES BY VARIOUS MODES"

Remarks by
Jacob W. Hershey
Chairman
American Commercial Lines, Inc.

I am here to speak in behalf of that mode of transportation which moves about 16 percent of the intercity ton-miles for about 2 percent of the freight bill. We are rather an invisible mode, but we think we're rather important, and we think we've got a lot of future. I don't think our future is behind us as some of the transportation people in Washington have occasionally indicated. As one rule of the thumb measure of what we can do on the Mississippi-Ohio River system, my company can take a ton of your bulk freight, and move it two and one-half miles for about one penny. We will not, however, move it as fast as Mr. Healy's company.

As many of the earlier speakers have pointed out, increasingly one of the most interesting problems in transportation is not the invention of improved, more efficient, or cost-reducing technology, but the difficulty of getting new technology applied for the benefit of all through the maze of bureaucratic restraints. Now in a brief period of sunshine in the early 70's, the Water Transport Association (of which my good friend John Creedy here is president), the Association of American Railroads, and the American Trucking Associations together devised a program which was to be the beginning of an industry-wide effort to improve transport efficiency for all the modes. The Surface Transportation Act, on which we all worked, provided for government investment funds to improve railroad efficiency and rehabilitate the ailing railroads. Most of the program was for railroads, but all the modes subscribed to the overall goal. We were at that time addressing ourselves both to the improving efficiency and to the major problems of expanding national transport capacity to keep pace with the growing economy.

A joint theory often repeated was that all the modes would be needed. Now, however, it appears to me that there is a sort of negativism in the railroad industry. All those enlightened railroad people who once talked about improving the efficiency of all modes for the benefit of the nation seem at least temporarily to be submerged. But the sound approach to policy-making must remain the all-modes systems approach. From the system point of view of promoting the lowest cost, most fuel-efficient, and safest means of transport, the water carrier industry has got a lot to offer.

First, its capacity can be expanded with less private and less public expense than any other surface mode. It is true there are relatively few bottlenecks on the river system, but those which do exist are critical and present significant opportunities for improved efficiency. The inland water highways are in place and need only relatively minor improvements to permit major capacity increases. Potential for capacity increases in the Great Lakes is virtually unlimited, and of course the capacity of domestic ocean routes is similarly unlimited.

Second, the opportunities for cost reduction are very favorable. The fundamental laws of physics govern the fact that a ton of freight transported on water takes less effort and less energy to move than a ton of freight on land. A tow of barges requires between 11 and 24 horsepower per 100 tons of cargo-move. A 175-car unit train in fair weather on zero grade requires about 44 horsepower per 100 tons. A railway tank car requires 1,543 pounds of steel per ton of capacity. A river barge requires about 430 pounds per ton of capacity. According to the 1970 and 1973 studies regarding fuel consumed per 1,000 ton-miles, the river mode requires only two thirds as much fuel as rail. The 1976 survey of water carriers showed substantial improvement over the 1973 figures.

These efficiencies and others were not easy to accomplish. By and large they represent the slow accretion of many types of technological improvements in engine performance, hull design, electronic aids, and operational techniques. The main thrust was simply, and is, the application of more horsepower to larger and larger barge tows. Flotillas of 30 and 40 barges containing 40,000 to 50,000 tons were currently being pushed by 10,500 horsepower towboats on the lower Mississippi River. This represents the present highest level of United States shallow draft technology. This is far and away the most advanced barging technology in the world. I might add here, though, that the national effort toward improving waterways on the part of many countries abroad, particularly Russia, France, and the Low Countries, is going at a much faster pace than it is in the United States at the present time.

So powerful has been the drive for improved productivity over the past 20 years that on the

Mr. Hershey is also director of a number of organizations including the 1st City National Bank of Houston and the Texas Gas Transmission Company. He has served as chairman of an exchange delegation to observe waterways in the Soviet Union.

lower Mississippi in the decade preceding the onset of serious inflation in the early 70's, average revenues per ton-mile actually declined. For the future there are many opportunities for cost reduction.

If I may be permitted a personal reference, I got started in this water transportation business with a small oil barging company many years ago on the Gulf Intracoastal Canal, which operates from the Mexican border in Texas to Florida. This company has since grown and evolved into next-to-the-largest barge company in the United States. But it's also the best [laughter]. It is an interesting operation down there. The typical operation today is limited by the 15-foot width of the channel to a four-barge tow pushed by a small 760 horsepower boat. Now this little canal was authorized in 1905 and the projected tonnage was five million tons a year. It is now transporting in these small tows over 100 million tons a year. The cumulative benefit cost ratio of federal investment in transport facilities, measured in terms of transport savings, is calculated at 26:1.

My studies of widening the canal from the Sabine River to Galveston, which is a short segment in the area but a typical one, shows that a 200-foot width would permit operation of tow units of eight standard cargo barges (two abreast and four long) about double the size of the present operation. Factoring in the additional cost of an 1800 horsepower boat to replace the 760, we would show a 29 percent reduction in overall ton-mile cost; this would be typical for the canal's other segments. Now that's a pretty big increment! A 29 percent reduction in transport cost for the energy and chemical cargoes which dominate that canal would be well worth achieving. I doubt whether there are many other opportunities for cost reduction on the inland waterways system quite equal to that particular segment.

And of course we come to the well-publicized bottleneck represented by the obsolete lock-and-dam . . . 26 at Alton, Illinois, which is the confluence of the Illinois Waterway, the Missouri River, and the upper Mississippi. Recent experience of delays at this highly congested lock show that barging costs have increased 20 percent on the St. Louis to Chicago sector of the waterway. For each 24-hour delay here, 10 percent of the fleet working in the area is immobilized. Another major opportunity for cost reduction lies in the combination of the best efficiencies of rail and water, and here we come to the intermodal aspect.

I might, if you'll give me another personal reference, point out that Texas Gas Transmission Company, which is really our parent company, is involved in gas pipeline business, trucking business, and the barging business. They are all profitable, and the only reason they're profitable is we've never let one division impose management on the other.

Savings have been achieved in combining transcontinental rail with ocean container operations. The Detroit-Edison Company has announced that its customers will save a billion dollars over the next 26 years from the new 1,700-mile Burlington Northern-American Steamship Company intermodal movement of western coal via Duluth. This is real progress. But there is often resistance to combining the best efficiencies of rail and water. Much could be saved if the present roadblocks to coordinated service were removed. It is my view that such coordination can be attained without common ownership.

The question before us today in reality is whether cost-saving technology will in fact be allowed to provide its benefits, or will be suppressed as a matter of public policy in order to protect another mode, in this particular instance the rail mode, from competition. In fact, despite rising production in terms of ton-miles of about 5 percent a year on the inland waterway system, the annual government appropriations for new water projects in constant dollars are today half of what they were in 1966. In 1966 the federal appropriations for new work amounted to about $1.25 per 1,000 ton-miles moved in that year. They are now down to about 50¢ expressed in terms of constant purchasing power.

The rail mode has dedicated itself now quite hopefully to the suppression of what it fears is more efficient cost-reducing competition. It has mounted a very clever – and so far successful – campaign to prevent the application of coal slurry technology, which claims major transport savings. It opposes increases in highway sizes and weights which would permit cost savings improvements in highway technology, and it is prime mover in opposing navigation improvements, except those in seaport harbors which benefit the railroads. Now this is nothing but pure protectionism. As an excuse the railroads argue that there is inequity in the use of federal funds. They also say that the root cause of their difficulties is the pressure of their water competitors. The cures they propose, of course, benefit both the faltering and the many prosperous southern and western railroads. So is there an inequity? Are the rails disadvantaged in the use of federal funds in transportation? Is competition the root cause of the rail problem? We don't think the answers are hard to find.

Railroads' complaints of unfairness over federal investment in navigation, which is part of the multi-purpose water resource development program, are without foundation. The use of federal funds by railroads dwarfs everything on the water side. Take the $250 million a year federal rescue of the railroad retirement program, which alone about equals the annual amount spent on shallow draft maintenance on the nation's waterways. Why did the fund need rescuing? Because railroad productivity has improved and there are fewer railroad people contributing to the fund. So the federal government makes up the shortfall, in effect, helping to pay for the part of the cost of improving rail productivity. We don't think that is different in principle from deepening a river channel which improves navigation productivity.

A big item involving hundreds of millions of dollars a year is in the tax incentives — both in the inordinate benefits which railroads receive from incentives which apply throughout the economy and in the special benefits they receive which no one else gets. These indirect benefits go to the prosperous railroads such as the Norfolk and Western and the Southern, and wealthy western railroads which have been complaining most about their competition.

One complaint of the railroads is that because of the use of federal funds for navigation they do not have the financial strength to compete with water carriers. In any analysis of relative financial strength, accounting of current values of revenues from land grants would be relevant. We do not agree with the railroads that all those grants have long since been paid for by reduced rail rates on government traffic. The timber, metallic ores, oil and gas, and coal revenues and reserves should definitely be taken into account in this dialogue. If the argument is that the public has received the benefit through reduced government freight costs in the case of the land grants, then likewise all navigation investment has been, and is being, paid back in savings on waterborne competition. In both cases the public at large has benefited.

There are only a few of the many examples of the use of federal funds on the railroad side. In addition is the $6.4 billion array of financial aid in the 1976 4-R Act, and more still in the new "Son-of-Conrail" Act passed later in the session. Under the 4-R Act, in Section 902 calling for a study of aid to rail transportation, DOT has a great opportunity along with plenty of funds to put into perspective the role of direct and indirect aids along the lines above in this study. If it fails to include both the direct and indirect aids on the rail side, its study will be worthless.

Leaders of the Commercial Budget Committee, representing Brock Adams and Jim Wright of the Public Works Committee, are beginning to talk about the establishment of a combined transport account in which federal aids to transport would be reported and dealt with in one place. This might make a lot of sense. Such a combined transport account would be incomplete, of course, unless all direct and indirect programs are included. A complete accounting of all public contributions, both current and historical, would be of great assistance in the formulation of policy. While they're at it, the budget committees could assist policy-making by providing information to compare the direct and indirect aids for transportation with those for other segments of the economy. This would not only demonstrate that the government gets more for its money out of the transport investment than almost anything else it does, but would reveal that absence of user taxes on the waterways is not at all out of line with the accepted standard for public policy. I know of no serious study which demonstrates that the pressure of competition has been a major cause of rail problems; far from it, where water competition is most in evidence in the South, it is no accident that the railroads are both efficient and very prosperous.

In summary, we find no inequity in the use of public funds between the water and the rail modes. The root cause of rail problems is not the competition. The cure of the rail problems, therefore, cannot be to frustrate the efficiency of pipeline, truck, and water-carrier competitors — comforting to the rails as that might be in the short run. The cure is, instead, approving efficiency everywhere, overall. No doubt, the variety of programs already enacted will be helpful in promoting rail efficiency. We think the water efficiency improvement is moving along in a steady fashion. The private sector of transportation must bear its proper burden, and the government must do what only the government can do. Improved transport efficiency pays handsome dividends to the public, and making improved efficiency possible must continue to have a high priority on the public agenda.

DISCUSSION PANEL

"PROJECTED TECHNOLOGICAL RESPONSES TO PROBLEMS AND CHALLENGES BY VARIOUS MODES"

Remarks by
Tracy S. Park, Jr.
Vice President
Tenneco, Inc.

Pipelines as a Mode of U.S. Domestic Transportation from the Present to the Twenty-First Century

Pipelines constitute the silent transportation mode in the United States. They are generally out of sight, except for occasional low-profile pumping or terminal facilities. Existence of such stationary facilities is seldom objectionable to local rural residents; in fact, steady employment and other economic benefits to the community invariably are a by-product.

Pipelines as a Freight Mode

The vast majority of all presently installed pipelines in the United States are handling crude oil, refined petroleum products, or natural gas. Tonnages hauled through other pipeline systems transporting non-energy-related chemicals or gases are so negligible in comparison that they are outside the scope of this presentation.

For calendar year 1975, crude oil and petroleum products pipelines alone accounted for about 510 billion ton-miles of freight, or roughly 25 percent of the total U.S. domestic freight of 2,070 billion ton-miles hauled, excluding natural gas. Freight transport in natural gas pipelines from producing fields to urban markets added an additional 264 billion ton-miles. Thus, the nation's primary pipeline systems, all hauling hydrocarbon fossil fuels, accounted for 774 billion ton-miles of freight. This impressive figure is 33 percent of the 2,334 billion ton-miles of U.S. domestic freight hauled in calendar year 1975.

Between the periods 1947 and 1974, the U.S. wholesale price index increased by 109 percent. Oil pipeline revenue during this period increased only 10 percent (from .292 cents to .321 cents per ton-mile). By comparison, Class I rail went from 1.08 cents to 1.85 cents per ton-mile and Class I trucking went from 4.85 cents to 9.00 cents per ton-mile, representing increases of 71 percent and 86 percent, respectively. At .321 cents per ton-mile, hauling products through oil pipelines represents roughly one-sixth the cost of transporting freight via rail.

Total personnel employed by all private pipeline companies are fewer than 50,000, or less than two-thirds the number of employees in the U.S. Department of Transportation. Compare this with the roughly 2.5 million people employed in the other primary freight modes of air, rail, water, and trucking. Even the casual observer will note that primary pipeline systems are not labor intensive.

Mileages of all U.S. domestic pipelines in the ground total 425,000, and are exceeded only by the mileages of national and state highways, including secondary roads, which comprise about 682,000 miles. Pipeline mileages exceed, individually, airway route, rail, and waterway mileages — and each by a considerable margin. The next investment in pipelines is below its proportionate share of total domestic freight hauled. For example, while accounting for 33 percent of total domestic ton-miles hauled, pipelines represent only 25 percent of total net investment for all transportation modes.

Pipelines in the United States essentially are hauling liquid or gaseous fossil fuels. They directly support the energy requirements of the nation. All natural gas is delivered by pipeline, from the producing fields all the way to the residential and industrial end user. About 50 percent of all petroleum tonnage is transported by pipeline, with roughly 30 percent going by truck and 20 percent by water carrier. Rail transport of petroleum products is almost negligible.

The total U.S. energy usage in 1975 was approximately 73,000 trillion Btu. Of this amount, about 31,000 trillion Btu was supplied by petroleum and approximately 22,000 trillion Btu by natural gas, for a total of 53,000 trillion Btu by the two energy forms. Together, oil and gas supplied over 70 percent of total U.S. energy requirements in 1975. Since oil pipelines hauled 50 percent of all petroleum tonnage (15,500 trillion Btu), and natural gas pipelines hauled all the gas tonnage (22,000 trillion Btu), the U.S. private pipeline industry delivered to primary markets about 37,500 trillion Btu, or slightly over 50 percent of all energy used in the United States during 1975.

Energy Efficiencies of the Primary Freight Modes

Fuel used in the transportation industries, including all of its modes and supporting operations, accounts for about one-fourth of the total U.S. energy consumption. More than half of U.S.

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petroleum supplies are used for transportation, and petroleum provides over 95 percent of the energy input to the transportation sector. It is interesting to note present-day energy requirements for freight traffic for each of the five principal modes, as shown in Table I.

These requirements bode well for future utilization of pipeline, waterway, and railroad modes in an era of future high energy cost. Indeed, if we assume an evolutionary shift in modal mix towards greater energy-efficiency, a projection to the year 2000 might appear as shown on Table II. Note the decline in energy-efficiency (Column 9, 14 percent) between 1950 and 1970 because of the increased use of trucks and airplanes and the steady decline in the use of railroads. Freight traffic increased 77 percent during this period while total freight energy requirements increased by 102 percent.

Because of economic constraints which might be placed on expansion of low energy-efficiency transportation modes (trucks and airways) in the future, the "modal mix" of freight hauled may change in favor of rails and pipelines, and to the detriment of trucking, as shown in the projections of Table II. If the pipelines' share of total freight increases up to 29 percent as projected, the industry must effectively utilize all the technology it currently possesses and is able to develop. The industry also must be allowed to operate in a favorable economic climate in the United States, without stultifying or unreasonable legal interference from environmentalists or the U.S. Congress. We now will consider the utilization of fossil fuels availability and pipeline technology.

The Role that Imported Liquefied Natural Gas Must Play

In the United States, the price of natural gas in the interstate market has been maintained at an artificially low level on the grounds that this is in the best interest of the public and the consumers. The resulting stimulation of demand has caused a serious supply dislocation, which now is producing severe curtailments.

The present annual gas supply of about 20 trillion cubic feet can be maintained well into the 1980's in spite of currently falling production levels if suitable economic incentives to promote domestic production are soon instituted. Even with such incentives, and the successful importation of now-abundant natural gas from Alaska, supplemental supplies, including gas manufactured from coal (SNG) and imported liquefied natural gas (LNG), will be required to meet demand. By 1990, LNG imports into the lower 48 states must total between 1.75 and 3.0 trillion cubic feet annually. The higher figure would represent about 8 percent of the nation's gas supplies and about 60 percent of new gas supplies.

The technology for liquefying, transporting by special tanker, and vaporizing LNG into existing pipelines already exists. Commercial LNG operations started in 1964, and nine projects worldwide currently are operational. The quantity of LNG involved is roughly .65 trillion cubic feet annually, with 49 percent going to Japan, 48 percent to western Europe, and 3 percent to the United States. The principal exporting countries are Algeria, Libya, and our own state of Alaska.

There are six new firm projects, three of which are directed to the United States, totaling roughly .75 trillion cubic feet annually. The first of these, presently under construction at Cove Point, Maryland, will commence operations within the next year. This facility will provide gas via a new 36-inch diameter, 87-mile pipeline beginning at the LNG terminal and connecting with two major and existing transmission and distribution systems. Briefly, this, and other LNG projects to follow, function in the following manner.

Natural gas from a producing field, in this case located in Algeria, is liquefied using existing low-temperature, cryogenic technology. The liquid product at a temperature of minus 258 degrees Fahrenheit is pumped aboard special LNG tankers. These tankers, although large, are not in the ultra-large crude carrier (ULCC) class. The LNG is transported in heavily insulated tanks at a pressure of about 1 psig. It remains auto-refrigerated by being allowed to boil. Generally, about 2 percent of the cargo will boil off during the trip and is used for ship's fuel during the voyage, which for medium hauling distances will require about 10 days.

At the U.S. destination, the vessels are off-loaded into heavily insulated tanks at the terminal site. Sufficient storage is provided to allow constant gas deliveries with LNG tankers arriving on the average of every 2 to 3 days. Pumps raise the liquid to a pressure of 1200 to 1300 psig, and at this pressure it will enter the vaporizers. Hot water is the heat medium in the vaporizers, and it is here that the LNG will revert to a gas and enter directly into the transmission pipeline without further compression.

Over the next 15 years, LNG imports will represent a significant portion of new gas supplies. Its price will be higher than the regulated price of indigenous gas or of the average gas price if deregulation and rolled-in pricing are approved. However, for recently signed Algerian LNG projects, the cost-including-freight should be competitive with landed fuel-oil prices.

The Thrust of Synthetic Fuels Technology

The development of a viable synthetic fuels industry in the U.S. will reduce our dependence on imports – mainly crude oil and LNG – and help prepare us against the day when worldwide production of conventional oil and gas will not be able to meet demand. Long before that day arrives, the United States must have built a commercial-scale synthetic fuels industry. We do not expect synfuels to have a significant impact on the U.S. energy supply before about 1990. We do expect to see a synfuels industry established and operated by the private sector by that time, and it should contribute about 3 percent of the nation's total energy needs by then. Private industry's pipeline systems will transport most of these fuels, since they will be almost identical in physical characteristics to the various petroleum liquids and natural gas presently flowing through them.

Commercial synfuels processes based primarily on coal and oil shale will play important roles in the future of the U.S. gas and petroleum pipeline industries over the next several decades. Coal and oil shale can be converted into a variety of liquid products, ranging from heavy fuel oils up to gasoline and methanol. Coal can be converted into a substitute natural gas (SNG) of present-day pipeline quality, that is, sulphur-free gas having a heating value of about 960 Btu per cubic foot.

Thousands of miles of additional pipelines will be constructed originating in the western states of the U.S. when the technical and economic feasibility of synfuel production processes have been proven. The huge coal and oil shale deposits underlie portions of Colorado, Utah, Wyoming, Montana, and North Dakota. From oil shale it is estimated that about 75 billion barrels of oil can be recovered from richer zones that are susceptible to present mining and retorting technologies. From our total coal resources, roughly 250 billion tons can be recovered with today's technology and economics. This is equivalent to about 900 billion barrels of oil on a heating value basis.

The recoverable energy from coal and shale, and available with today's mining and pipeline transport technology, would sustain the nation's combined present total annual energy demand for 65 years. If future technology will permit us to recover most of the coal and shale deposits that probably exist, the energy they provide would last, at present consumption levels, for 500 years. If we assume total demand for energy will grow at a compounded rate of 3 percent into the future, then the total probable coal and shale deposits would last the nation about 110 years. Although this analogy does not allow for non-energy uses of coal, it is obvious that over the long term, coal – and to a lesser extent shale – will be a major source of liquid, gaseous, and solid (see discussion below) fuels for our pipelines to transport.

On the basis of 1975 petroleum costs, none of the synfuels, gas or liquid, are competitive with the regulated price of domestic crude oil. Shale oil from mining and surface retorting is close to being competitive with imported crude oil. Synfuels' future competitiveness will depend on the prices of crude oil, coal, and natural gas.

Of the various synfuel possibilities, coal gasification technology is the most advanced. The Lurgi Process is one which now is readily applicable to the production of SNG. Many commercial Lurgi plants are in operation abroad producing a low-heating-value gas of 400 to 550 Btu per cubic foot heating value. To manufacture high heating value pipeline quality gas, the Lurgi gasifier process can be upgraded by catalytic methanation (addition of hydrogen). The process is fully commercial on noncaking coals containing few fines. Proposed projects in the western part of the United States are fully technically feasible. However, the cost of pipeline gas from the Lurgi process is estimated to be 20 percent higher than from "second generation" processes which are still in the developmental stage.

At the present time no commercial gasification or liquefication projects are in the construction stage. Many time delays have been caused by the lack of governmental policy on how the high cost of the gas or liquid will be handled.

Pipeline Transport of Coal

Any review addressing the technological capability of primary pipeline systems to handle an increasing share of the nation's freight for the next several decades would be incomplete if it omitted a status report on transport of coal. The first coal pipeline was completed in 1957, in Ohio, and carried 1.25 million tons of coal a year for six years. Its objective of providing low transportation costs was confirmed when railroad rates for the district were reduced to below the cost of pumping coal. Since 1963 the line, extending from Cadiz, Ohio, to Cleveland, a distance of 108 miles, was placed in standby status. This line stimulated the development, in railroading, of the unit train concept, with resultant moderation of rates.

Another successful coal pipeline project, and the only one currently in operation within the U.S., is the Black Mesa Pipeline. In operation since 1970, Black Mesa transports five million tons of coal annually through a 273-mile, 18-inch diameter line from a northern Arizona coal mine to an electric power generating plant in southern Nevada. The rugged terrain had an economic effect on the decision to transport coal by pipeline rather than by railroad. Rail movement would have traversed 408 miles and have required 150 miles of new track.

In order for coal to be pumped through a pipeline, it must be transformed into a "slurry." Water is used as the transporting liquid and is mixed with pulverized coal (smaller than 1.0 millimeter) in the approximate ratio 50 percent coal to

50 percent water. A preparation plant receives coal from the mine site and crushes it in several steps to a fine particle size. It is placed in slurry tanks and agitated while stored, and then pumped from the tanks into the pipeline. An adequate water supply must be available near the pipeline origin, and the pipeline terminus must incorporate suitable means of water disposal.

The pump stations vary from those on conventional petroleum pipelines in that the pumps are reciprocating rather than centrifugal. Special internal materials are used in the pumps to control abrasion and lengthen the time between overhauls. The velocity of the coal slurry must be closely controlled. The ideal speed of the slurry usually is about four miles per hour. At appreciably slower speeds, a formation of moving dunes or even stationary beds will occur. At higher velocities there exists the problem of erosion within the pipe caused by the scouring action of the abrasive slurry mix.

At the terminal end of the slurry pipeline, centrifuges are required for dewatering, which is an added expense. Only power plants are able to use a coal slurry, so the water disposal problem is not acute; it is used as a coolant in the plant.

Large distances are involved in transporting coal from the mines of the west (one of the largest is the Powder River Basin of Wyoming) to power plants in mid-southern, southwestern, and West Coast areas. Slurry pipelines are an alternative method of carrying part of the 500 million tons of new coal scheduled to be mined annually by 1985. Except for the use of barges where waterways are available, slurry pipelines probably are the most economical means of transporting coal. Moreover, the underground lines are silent and do not disturb the environments through which they pass. Labor and energy costs, both of which are subject to inflation, account for less than 30 percent of the freight charge with a pipeline. These same costs can add up to 80 percent of the charge with a surface transportation system.

There presently are six proposed U.S. slurry pipelines. Four of the six projected systems exceed 1,000 miles in length, with pipeline diameters varying between 20 and 48 inches. The total potential annual throughputs range from 85 to 102 million tons per year, and they all will be providing fuel for urgently needed electrical power plants.

The proposed coal slurry pipelines cannot move into the actual planning and implementation stages because of governmental indecision and lack of an energy policy. The U.S. Senate passed a bill in 1974 giving coal slurry companies the right of eminent domain and permission to cross government lands, but only if they do not transport their own coal. The House of Representatives is still studying the measure — a jointly approved bill has not been brought forward and eminent domain for the coal slurry companies has not been granted.

The Dawn of a New Era for Pipelines

Since 1968 large quantities of big pipe, 24 inches to 56 inches in diameter, have been supplied to the worldwide oil and gas industry for construction of pipeline systems. This demand primarily has been associated with extensive looping projects that were needed to increase the productive capacity of existing gas and oil fields. During this same period major petroleum producers and gas pipeline companies have been investigating the technical and economic feasibility of developing new oil and gas reserves far from the marketplace.

Changes in long-established supply patterns have had a dramatic effect in raising petroleum prices throughout the world. This political action further has intensified interest directed toward bringing to market the huge gas and petroleum reserves lying deep beneath the oceans and in the Arctic permafrost regions of North America and the Soviet Union. A technological pipeline revolution is under way worldwide, because construction and operation of large diameter pipelines in severe environments requires major engineering and design studies.

Pipelines are efficient, and in a class by themselves for moving high-volume, uninterrupted quantities of liquids or gases. For example, doubling the number of tankers in a fleet will double the quantity of products transported. Doubling the diameter of a pipeline will quadruple its flow. In the pipeline industry, as in other industries, we have what is known as economies of scale. By transporting greater volumes in larger diameter lines, it is possible to achieve lower unit costs. The investment and operating costs per barrel of liquid or per thousand cubic feet (MCF) of gas decreases rapidly as the total capacity of the line increases. Moreover, the same amount of horsepower applied to a large diameter line as compared to a small diameter line will provide more than proportionate increase in throughput. Increasing returns are attributed to the fact that there is less friction incurred for each unit of product carried in a large diameter pipe than in a small diameter pipe. Pipe friction is created primarily by that part of the liquid which comes in contact with the inside surface of the pipe. It is the amount of surface area per unit of product that determines the amount of friction in a line.

Because of the large volumes required to realize the economies of a large-diameter pipeline, it presently must be a common carrier line, as no one company usually has oil or gas supplies, refineries, or markets large enough to supply the volume required for a large diameter line.

The basic premise of pipeline economics is the need for adequate, dependable, and reasonably priced transportation. Before the never-ending search for energy supplies went offshore and to the Arctic regions, we also used to think in terms of "low-cost" transport as applied to a proposed pipeline project. Now, many self-appointed protectors of the environment, acting with authority and no responsibility, are making their mark on new pipeline projects with dollar signs – dollars that will be contributed by all who buy fuel for their car, truck, tractor, or furnace.

The Trans-Alaska pipeline, now nearing completion, marks the end of one era of pipelining and the beginning of another. The 2,000,000 barrel per day Trans-Alaska system is being built for the purpose of making the huge crude oil reserve at Prudhoe Bay available to U.S. industry and consumers. The line, 48 inches in diameter, traverses some of the most rugged terrain in North America. Never before has a project of such magnitude been attempted in such a hostile environment. The southern end of the 800-mile line terminates at Valdez, an ice-free port on the Gulf of Alaska. There, crude oil will be stored in multiple 510,000-barrel tanks for loading into tankers varying in capacity from 45,000 to 250,000 deadweight tons.

The Arctic and sub-Arctic environment across which the line is being constructed presents many problems not encountered in past pipeline projects. More than half the line is underlain by permafrost, which is a permanently frozen layer of soil and subsoil. Also, detailed studies of animal habitats, migration trails, locations of fish spawning, bird nesting areas, and a multitude of other investigations were required. Altogether, there were more than 350 stipulations imposed on the design and construction of the pipeline by various federal and state agencies.

The most unique design and construction feature of the project is the above-ground concept used for over half the line's distance. This was due to unstable permafrost conditions that exist. Since the oil handled by the pipeline is about 135° to 140° Fahrenheit, burying in the conventional manner in permafrost areas would result in melting of the permafrost and the loss of adequate support.

The pipeline, owned by eight oil companies and designed for a 30-year life, is now forecast to cost $7.7 billion. This figure exceeds the total cost of all other crude and products pipelines in the United States. It is the greatest engineering and construction achievement in the history of free enterprise.

Pipeline Technological Improvements

A completely new set of line pipe standards are being developed by the world's steel producers. High performance line pipe is now an economic necessity because of the geographic locations of our undeveloped (and to a large extent undiscovered) supplies of crude oil and natural gas. More specifically, these geographic locations are in the Alaska Arctic; northwestern Canada and the Canadian Arctic; the U.S.S.R. Arctic; and the North Sea. High performance line pipe is an absolute must for transport of natural gas from the Arctic regions, since it flows at very low temperatures.

For high throughput pipelines operating in low temperature Arctic service at pressures in excess of 1600 psi, special qualities of strength, fracture toughness, and weldability are being developed by pipe manufacturers. In the metallurgical design of high strength steels for low temperature Arctic service, hot rolling practice as well as alloy composition is being considered in minute detail.

Pipelines are designed with allowable design pressures stated as a percentage of the yield strength of the plate steel from which the pipe is rolled. Thus, the greater the yield strength available in the steel, the larger the diameters and resultant flow-capacity of the pipeline. The prime contender for Arctic application is an acicular ferrite, high strength, low alloy, low carbon steel containing manganese (Mn.), molybdenum (Mo.), and columbium (Cb.). Commercial data already have proven that Mn-Mo-Cb steels comply with the harsh requirements of Arctic line pipe application. Yield strengths in excess of 70,000 psi are available, and there is an excellent possibility, through minor variations in composition or application of tempering treatment, to reach and make standard even a 100,000 psi yield strength level. These high strength acicular ferrite steels capable of operating in temperatures as low as minus 80° Fahrenheit represent the metallurgy of the future for severe-service pipelines. They will no doubt become materials for widespread use as steel and pipe producers the world over commence manufacture in the coming decade.

In addition to advances in steel line pipe metallurgy, equally important technological improvements are being made in pipeline protective coatings, cathodic protection, automatic welding and underwater welding, valve design, instrumentation, computer controls, and construction techniques, including the use of lay barges for offshore lines. Altogether, there exists an imposing array of specialty equipment manufacturers and contractors ready and able to assist the transporters of petroleum and gas in meeting their commitment to stockholders, industry, and the public. Pipeline technology is advanced and qualified supporting personnel are adequate to proceed with development and transport of North American petroleum and gas supplies to the marketplace.

Need for Positive Government Action

Industry efforts to ease the energy shortfall have been stymied at every turn by the U.S. Congress, which has produced disincentives rather than incentives. Lack of a national energy policy, with commitments, continues to create an atmosphere of uncertainty which is slowing our growth. This condition does not exist in energy resource development in most geographic areas outside North America. A failure by the United States to act on energy will have dismal economic consequences for Europe and Japan. Because of economic and political interrelationships, this in turn would produce negative effects upon the United States.

A major impediment to development of the nation's oil and gas transport system recently has been the snail's pace at which some legal problems of siting transport facilities are resolved. Caution should be maintained to guard the environment but at the same time provide legal procedures that prevent delays in building facilities for periods of five to seven years beyond the date they are needed.

About 40 percent of the natural gas transported to the northeastern United States now is produced from offshore Louisiana. Many sincere citizens and leaders in the Northeast still have an ill-founded and inexperienced fear of offshore oil and gas resources development and pipeline systems. The shared experience from offshore Louisiana and from the British, who rapidly are developing their North Sea resources, should be important in closing the information gap between residents of the Northeast and the petroleum and natural gas industries. Perhaps with the added expertise of such technical organizations as the Woods Hole Institute in Massachusetts, the East Coast offshore fossil resources can be developed with informed confidence.

The Mixed Hydrogen-Electric Energy Delivery System*

As fossil fuel resources become depleted, energy planners are looking toward new sources to supply the constantly increasing energy requirements of mankind. Even coal, our most abundant fuel, probably will reach a maximum production peak within the next 15 to 20 years and then begin to decline. The clock has started on the lead time period required to develop and introduce the next energy supply technology.

Nuclear and solar energy generally are considered the only sound long-term solutions to the world energy problem. Conventional approaches to the use of these two energy forms rely heavily on converting them to electricity which can be transmitted to the ultimate consumer. Thus, many planners assume that the nation is moving toward an all-electric economy.

It is not at all clear to many engineers and scientists that our future society – say starting around the year 2000 – will be an all-electric one. There could be an important role for a gas energy delivery system to play, even after fossil fuels and coal are near depletion. The logical gas is one of nature's most abundant fuels, although in captive form – hydrogen.

This concept envisages that a primary energy source, solar or nuclear, will be used to convert water into its elements, hydrogen and oxygen. The hydrogen gas would be transmitted via pipeline to the user and employed directly as a fuel in the same manner as natural gas today. When hydrogen burns, water is the only direct combustion product. Water already is present in such abundance and so mobile on the earth's crust, no permanent dislocation would be produced in nature's balance. Hydrogen is the perfect ecology fuel, a virtually pollution-free recyclable fuel. While hydrogen is not naturally occurring or a primary source of energy, it is easily stored and transmitted. It becomes a means of making nuclear and solar energy sources available to the consumer in a clean, convenient, and flexible way.

Water can be converted to hydrogen and oxygen in several ways. Electrolytic hydrogen is produced by passing direct current through a conducting water solution, freeing hydrogen and oxygen separately at the electrodes. In another method, water can be heated to a sufficiently high temperature where it will spontaneously split into hydrogen and oxygen. In yet another method, called thermochemical splitting, water enters into a series of chemical reactions in which the intermediate chemicals are always recycled and the overall reaction produces hydrogen and oxygen in separate steps.

The chemical industry already operates its own small-scale hydrogen economy. Most of the hydrogen is produced and consumed on site in the manufacture of various industrial chemicals. While the chemical industry has looked upon and used hydrogen as a feedstock, the gas industry increasingly will look at it as a fuel by which it can hold and even develop its existing markets. In the beginning, the gas industry could cooperate with the electric industry in producing electrolytic hydrogen from off-peak electric power and pipelining it for such applications as fuel cell generators, petrochemical plants, and steel mills.

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*Ref: D.P. Gregory.

In the long run, hydrogen produced from thermochemical decomposition of water and transported by pipeline might offer the keenest competition to conventional high voltage transmission of electricity. There is no reason why hydrogen should not be transported in the same way as natural gas today, that is, by underground pipelines that reach most industries and more than 80 percent of the homes in this country. Long-distance pipeline transmission of hydrogen is not carried out commercially today although a few industrial installations haul bulk hydrogen up to 100 miles. The comparatively low cost of energy transmission by underground pipelines, compared with overhead electricity costs, is a great asset to the natural gas industry, and this economy also appears to be applicable to hydrogen pipelines.

The heating value of hydrogen is only 325 Btu per cubic foot compared with 1000 Btu per cubic foot for natural gas. Consequently, three times the volume of hydrogen must be delivered to equal the same energy level as natural gas. However, the density of hydrogen is about one-ninth that of natural gas. Since the capacity of a given pipe is proportioned to the square root of the density of the gas, there is a compensating factor of one-third. As a result, a given length of pipe of a given diameter operating with a certain pressure drop across its length will carry roughly the same total Btu per hour when delivering hydrogen as it will with natural gas. Pipeline transport capacity for hydrogen will actually end up being somewhat less than for natural gas. This is because at ordinary, existing, maximum operating pressures of about 750 psi, the ratio of heating values is altered to the detriment of hydrogen. This disadvantage is minimal.

The greatest problem in comparing the two gases is that for hydrogen the pipeline compressors must handle three to four times the volume for the same energy delivery. Moreover, the horsepower required is raised by a factor of between five and six, which increases the cost of the fuel in powering the engines used to drive the compressors. As a result, it has been estimated that hydrogen transmission at a typical pipeline pressure of 750 psi will cost about two to six times more than today's transmission costs for natural gas. Even so, a 230-kV overhead electric transmission line operates at a cost at least 12 to 20 times more than hydrogen transmission.

It appears that if the operating metallurgical problem of hydrogen embrittlement and the engineering problem of compressor design can be resolved, future hydrogen pipelines will be feasible. A combination of electricity and hydrogen appears to be the goal for which we should aim. In a combined energy system of this nature, the natural gas industry will be able to maintain a leading role as a provider of convenient and efficient fuel.

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Question: Please compare coal slurry pipeline efficiency from mine to power plant with electrical transmission and with rail unit train.

Answer: I believe it would be safe to say that the slurry pipeline would be 30 to 40 percent more efficient than electrical transmission, and about 10 to 20 percent more efficient than the rail unit train. However, such generalizations do not account for haul distances, types of terrain, and, in the case of rail, whether the facilities are new or old. Accurate comparisons could be made only on a case-by-case basis.

Table I
Energy-Efficiency for Freight Transport*

	(1) Mode	(2) Btu per Ton-mile
1.	Pipelines	
	liquid	450
	gas	1,200
2.	Waterways	540
3.	Railroads	680
4.	Trucks	2,340
5.	Airways	37,000

*Ref: Hirst and Rice.

Table II
Freight Transport Historical Trends and Projections*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		Percent of Total Ton-miles						
Year	Ton-miles of Freight (excluding natural gas)	Rails	Trucks	Waterways	Pipelines (excluding natural gas)	Airways	Total Freight Energy 10 Btu	Btu per Ton-mile
		Historical						
1950	1090	57.4	15.8	14.9	11.8	0.03	980	900
1960	1330	44.7	21.5	16.6	17.2	0.06	1320	1000
1970	1930	40.1	21.4	15.9	22.4	0.18	1980	1030
		Projected						
1980	2400	41.0	18.0	16.0	25.0	0.20	2340	970
1990	2900	42.0	14.0	16.0	28.0	0.10	2500	860
2000	3400	44.0	11.0	16.0	29.0	0.10	2760	810

*Ref: E. Hirst.

DISCUSSION PANEL

"PROJECTED TECHNOLOGICAL RESPONSES TO PROBLEMS AND CHALLENGES BY VARIOUS MODES"

Remarks by
John W. Ingram
President
Chicago, Rock Island & Pacific Railroad

I used to start out my talks when I was at FRA with the statement that it is sort of like being social director on the Titanic. Great job, but you know, who knows about the future? It's sort of borne out by some of the talks today. I always like to hear Jake Hershey speak because he is so pleasant about the railroad industry [laughter] and its effect on the waterways in the past. Well, you have to get a couple of shots back. You just can't talk about the technology entirely. But I suggest that if he really wants to widen that river down there, to get the 26 percent increase in ton-mile cost . . . he ought to go ahead and do it. [laughter and applause]

I must say, though, there are certain efficiencies in water transport. We do interchange more freight with waterways than we do with trucklines; and we own a truckline, which I guess means that common ownership isn't all that good, or something. I'm not quite sure. But I am glad to be here, not just on my own behalf, but on the behalf of about 8,000 Rock Islanders, down from 12,000 Rock Islanders. You missed a great line, Charlie. We're the largest bankrupt railroad in the United States. [laughter]

We like to get invitations to come to prestigious conferences such as these. It's sort of a recognition of our continuing importance on the national transportation scene. And I was especially pleased to be here because the flier that came out on this meeting said we would be exploring ways of overcoming existing economic barriers. Now we're all in favor of that at the Rock Island. [laughter] And quite obviously that is one of the barriers that exists in implementing technology – the on-the-shelf technology, and the technological research that many of us would like to see done. Certainly true in the railroad industry.

The problem to a great extent is money. Without sufficient financing in a regulatory environment and a government bureaucratic environment where returns on investments are considered to be moral, proper, and something to be encouraged, I don't really think there is going to be any significant advanced technological implementation in the railroad industry in the future. Given the present state of the way railroading is allowed to earn a living, which is a far cry from the way broadcasters and race-track operators and defense contractors and other regulated but cozy-with-government industries are allowed to earn a living, I think there is an absolute minimum of possibility that internally generated financing is going to permit the introduction of advanced technology, or at least that part of advanced technology which could be said to improve the transportation product produced by the railroad industry.

Now of course there is always going to be a ready market for technologies that reduce costs and make it easier to live with the regulator. A considerable amount of what we do is involved there. And the situation isn't one of recent date. It is not something that young transportation scholars can tie to the collapse of railroading in the Northeast in the last sixties or early seventies. It's been this way as far back as I can remember. There's been a lot of steps. There has been a lot of publicity of those steps on the part of the railroad industry. I mean, after all, dynamometer cars were used behind steam engines.

The Pennsylvania Railroad's test bed at Altoona was sort of the marvel of its age. Robert Young looked very technological when he strapped a jet engine to the roof of a rail diesel car and whistled across Ohio at about 160 mph or whatever. But the railroad passenger business of course saw such things as the Talgocq train, and indeed there was a thing called the "Jet Rocket" on the Rock Island. It rocketed to Peoria. [laughter] It is now a museum exhibit in Green Bay, Wisconsin, in case anybody's really interested in it. And of course the railroad industry saw gas turbines, it saw coal turbines, it saw diesel hydraulics and the like – but these were all sort of one-shot affairs.

There never was, until the advent of the test center at Pueblo, or the establishment of TSC here in Cambridge, a place where we could even concern ourselves with adequate pure research into the kind of things that go to make up rail systems technology. Note that I said rail <u>systems</u> technology, not just rail technology, and I'll come back to that in a minute.

Even back in the days when the railroads thought they were making money – and I suspect they probably weren't even then – there was a tendency to shy away from pure research. All the books I read when I was a kid said that railroading was a mature technology. The experts thought

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Mr. Ingram has served four major railroads as well as the U.S. Department of Transportation in executive capacities. Prior to being named president and chief executive officer of the Rock Island in 1974, he served as head of the Federal Railroad Administration from 1971 to 1974.

there was not much left to learn. In fact, I remember running what we used to call File 13, or the Round File, at the New York Central when I was there. I was the fellow that inventors came to ask for that "little bit of money" that we heard about at lunchtime. And I said no to such inventors as the one that offered to correct the mistake of the railroad industry of the ages. I asked the inventor what the mistake was and he said, "Well, you've put the wheels on the cars and the rails on the ground. The rails belong on the cars, and the wheels belong on the ground." I scratched my head and I said "How come?" and he said, "Well, haven't you ever seen them unloading cans of peas at the A&P?" [laughter]

Then there was the fellow who wanted to run submarines through a pipeline. He admitted there was a problem with conning towers and pumps . . . and how do you get them back to the other end . . .

I had a lot of fun turning down a lot of inventors who wanted to improve a lot of things. But we did approve a lot of things, and we did do what our budget would allow us to do, which was certainly a far piece south of what ought to have been done in terms of producing a good transportation product in the railroad industry.

I think it is a good thing that the air cushion vehicles and the linear induction motor whiz-bangs and so forth are more or less moth-balled out at Pueblo, and that the so-called fast track at Pueblo is operational. I think it's delightful that we are going to see some freight research done that is long overdue in these facilities. And I think there is a growing conviction in the railroad industry that a lot of our so-called technological advances, for instance, the 100-ton jumbo covered hypercar, probably shouldn't have been invented. Maybe it should have been a 90-ton covered hopper car. Certainly the 100-ton one is tearing up the rail. And, you know, when you come to the conclusion (and it's true) that a normal load in one of those cars exceeds the elastic limit of the rail, you know you have a problem. Maybe in another 10 or 15 years sufficient research will be done to develop the truth of that situation. But it's too bad it was not done before the car was invented.

There are a lot of other extrapolations in the railroad industry that are not based on research. I think there are lots of areas where government can move ahead with industry and improve technology. The financial assistance provisions of the recently passed 4-R Act make possible purchases of some of the high technology that should be available, which should be a plus. We'll be applying for some money very shortly to put into an electronic car inspection system – seven million bucks. We can't really quantify the results. We think they are about two million a year. It looks like a good investment but it is something that we can't finance otherwise. So these monies that are available can be used (we hope) to provide that sort of payoff.

I think there are two items, well, three maybe – pure research, research into car design such as jumbo covered hoppers, and applied research and interest in public safety – that should be on the horizon in large volume. In addition, there is one more area that I would like to touch upon; it is the area that I think is most important. I think the real need for technological improvement in the railroad business is in the systems area, not in the transportation area.

I mentioned earlier that the way in which we are allowed to do business seems to militate against excess profits. Excess profits in the past seem to mean anything over 3 percent. Sometimes it militated against any profit at all. And I think that situation is going to improve, but I think that it is a question of improving it by looking at where the money is spent, what the railroad cost structure really looks like. Railroad cost structures are generally people-oriented. I think we have to start by looking at where those people are, and where technological advances are needed, to improve the situation.

For instance, we have a large classification yard at Silvis, that's a little town about 160 miles west of Chicago, near the Quad Cities. Trains come and go in five directions: mainlines to Omaha, Chicago, Kansas City; branch lines to coal mines at Lafayette, Illinois, Clinton, Iowa; and a few other places. We hire a lot of people to sit around there and make decisions: Which train goes on which track? Who goes next? What order will the cuts of cars be switched over the hump for classification? Should the hump indeed be used for all cuts of cars that are going to be classified at that yard? Where are the cabooses? How much power per train, and what are you going to use it for when it gets to the other end of the line? Is there a use for a locomotive in Kansas City that is presently in Silvis that is going to move freight that is presently moving from Chicago and hasn't even got there yet?

These decisions are made on a sort of minute-by-minute basis. They are a substantial part of the cost of operating a railroad. In fact, the transactional aspects of railroading are frequently more costly than the transportation effort in total is. I think one of the main reasons why railroads have found it very difficult to compete for freight involving less than, say, 250 miles of transportation (because the transportation is very simple to perform) is that the decision and transactional process involved in moving the freight is very expensive. I can go on and give you several more examples, but I won't bore you with them. I think it is something that is worth looking at. And I think you should.

Moving trains around is not the hard part of railroading. The hard part is to create a system that maximizes the priorities, the service quotient, and so forth, of the business at the same time it minimizes the transportation costs of providing that business. If we put our concern on the transactional aspects of transportation service rather than providing the transportation itself, I think we will make some very good strides in the service quality and the product quality that we are producing for our customers. I think we have got to learn to develop the tools to manage transportation rather than tools to produce transportation.

Let me give you a little bit of data, and it is just a little bit. It is some of the kind of data that I think you should all have when you start looking at transportation. First off, if you are going to look at any transportation or any piece of transportation or mode of transportation with the eye towards introducing technological improvement in that transportation, be very careful you know what the cost structure of that business is and its market structure. The two are interdependent. There is no way you can divorce the cost structure from the market structure. Then make sure that your figures reflect the facts that you are really trying to find. For instance, I'm not going to go into market structure today, but a lot of the data on air freight-forwarder shipments are wrong. I know they're wrong because my railroad moves almost all of the air-freight forwarder traffic between Chicago and the Quad Cities. Now you can call that a customer rip-off or a triumph of private enterprise, but the fact is, the data are wrong; it is actually moving in my train because it gets there just as fast as going out to O'Hare Airport.

Make sure you have the numbers right; make sure you have the data right. Now let's look at that cost structure: 60 percent of our cost is labor. Then all you have to do is look at the heads and see where they work: 10 percent of them fix the track; 10 percent of them fix the cars and locomotives; somewhere between 15 and 20 percent of them run the trains and yards that I talked about before. So we've got 15 or 20 percent producing transportation, 20 percent doing maintenance, and that leaves 60 percent to do something else. And that's after I fired 33 percent because they weren't doing anything. [laughter]

Now I submit that that other 60 percent that is still there and busy are really doing things that relate to what I call the transactional aspects of the railroad business. A little further investigation reveals another curious fact: that at least half of those transactions are either required or ordered by government . . . aha! You guys are part of what has to be modernized in the transportation industry. So when you get into this technological business, look to yourself. The way the railroad as a system relates to the government as a system is part of what needs to be modernized. It produces a considerable number of transactions for perhaps good and sufficient reason and perhaps not. But those transactions need to either be reduced, streamlined, or eliminated.

The second thing to look at is the transactions involving moving the freight. The third thing to look at is the hardware. (And this is in order of the economic importance to the railroad.) Then of course, overlying all this, we would like to have a little bit more research into materials – that elastic limit, and plastic limit, and so forth, of the rail does look to me like it's worth looking at.

I can give you an example from today's lunch. It is an example of one thing that I think is very important for government people to remember. When you see something absurd in the railroad business, look to government for part of the cause. The time and transit on those cars that vary from Wednesday to Thursday to Tuesday. Remember that? Well it seems that in 1920 (I think I have the date right), there was a law passed that allowed the shipper the right to route his freight. It sounds like it is something a shipper ought to have. What that (abruptly) created was a 400 percent increase in the amount of interchange that went on from one railroad to another. It increased the number of operative routes from, say, Boston to Chicago, from about 25 to about 400. It required that railroad freight trains (and this is of course where we get into this problem of being unable to predict what day the stuff will arrive) to make tremendous numbers of stops to take a car out of the train because some shipper decided to route it a different way that day. It made it impossible for a railroad to plan ahead on precisely what kind of transportation it should produce except on a day-to-day basis based on the routing that the shipper chose to use that day. It also expanded tremendously the amount of railroad freight salesmen, because, instead of soliciting other railroads for interchange freight, they now had to solicit the customers for interchange freight.

I am not saying it's good or bad, but there is a reason for it. The railroads have a long history, and you usually find that there is some government input into anything ridiculous that's going on on the railroad. [laughter] I suggest that if we want to make that last slide in the picture a sunrise instead of a sunset, we all work together on all of these transactions we are causing each other.

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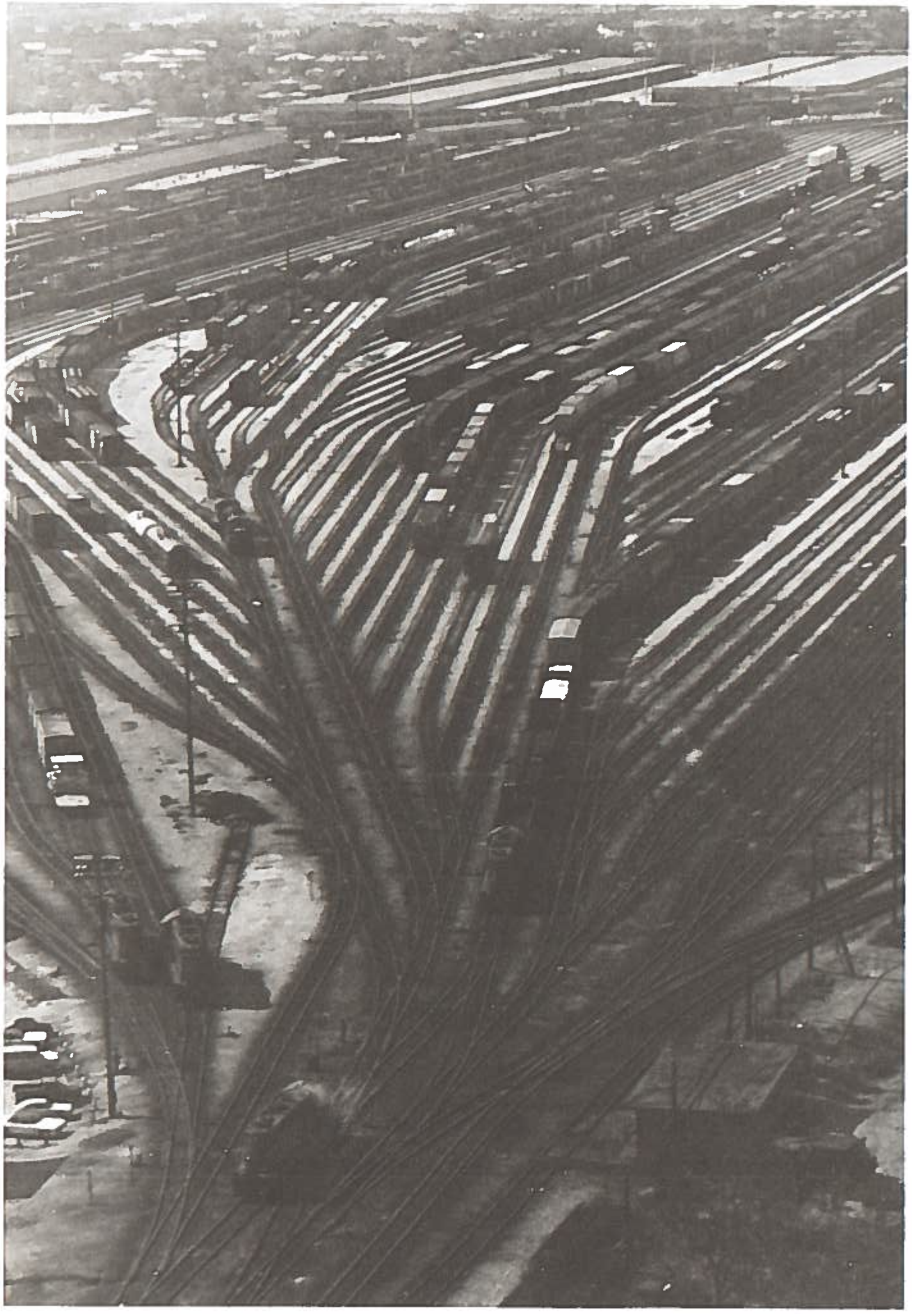
Question: As one of the largest shippers, would you support the adoption of a "standardized bill of lading" which would replace the various waybills, freightbills, and so forth, currently existing?

Answer: . . . Our fellows who deal with such things . . . tell me that it is a scheme (and I quote them) to spend railroad money without producing any return. They say they can find no conceivable benefit to us from such a bill of lading but considerable costs. Hence, we are opposed to it.



DISCUSSION PANEL

"A CRITIQUE OF PROJECTED TECHNOLOGICAL RESPONSES BY VARIOUS MODES"

Introduction to Panel by
William D. Owens
Deputy Assistant Secretary for
Systems Development and Technology
U. S. Department of Transportation

We have heard the challenges and problems from the economists and the shippers, and we have heard the response from the industry leaders, the people who look at opportunities as problems dressed in work clothes. Now it's time for a critique from this panel, which has been labeled "A Panel of Experts from Other Publics." I have tried to think of a twist on the "other publics," but, if you think about it, they all turn out wrong, so I won't do that. The only improvement I could come up with was to add the superlative "outstanding" to the description of the panel's makeup.

As you will soon find out, these people bring quite a remarkable diversity of accumulated wisdom to the table. We are going to get a look through the eyes of the Sierra Club from Linda Billings. We have a labor perspective from R.V. Durham of the Teamsters. And then we have three modal transportation overviews: one by Bill Harris of the Railroad Association; Ed Kiley from the Trucking Association; and Pete Albert of Shulman Air Freight, who is going to discuss things from the air side perspective. Since we are short on time, I will let you read their bios in the write-up, and kick things off by asking Linda to give us her perspective.

DISCUSSION PANEL

"A CRITIQUE OF PROJECTED TECHNOLOGICAL RESPONSES BY VARIOUS MODES"

Remarks by
Linda Billings
Washington Representative
The Sierra Club

I am truly delighted to be here today. I was trying to think of something funny to say, but I decided it would just be whistling in the dark. I really am quite impressed with this group of people and with the subject of the conference. I appreciate very much your willingness to hear the Sierra Club's views, or what little part of them I can give in this short a time. I also appreciate your recognition of the environmental component.

Contrary to wishful thinking, I think the environmental movement is alive and well. It is growing stronger every day, as the memberships of our organizations attest. The concern for the quality of life is here to stay. I do not see any retrenchments or backtracking on this. I believe, as do members of our organizations and the organizations which we have a common link with, that the environmental component is a positive force, not a negative one, as has been said by those who like to make environmental or consumer concerns the economic "whipping person." [laughter]

It looks as though there will be a growing focus on transportation issues among the environmental community. This has been lacking, and I think that it's still comparatively miniscule. As the realization begins to dawn on people of the enormous importance and impact that the transportation sector has upon our lives and our society, you will see a growing interest and focus on transportation among environmental organizations.

The connection between environmental concerns and future technological developments in transportation is perhaps symbolized most vividly by the battle over the SST. But the association should not seem to be all negative. Environmental and consumer concerns should also be viewed as a positive impetus to technological improvements in transportation systems because there are so many problems to be overcome: noise, air pollution, congestion, and so forth. We should take heed of the lessons from NEPA. The National Environmental Policy Act should be viewed as a positive force — not a negative force, as it is primarily thought of by some people, especially in the transportation sector. NEPA is a positive force because it requires that environmental and social concerns be plugged into the beginning of the planning process. When these are not addressed right from the beginning, and they come along as afterthoughts, then there will be delays, and even failures.

Environmentalists see better planning for transportation systems at the regional and the national levels as being one of the most important issues to address. This will require institutional changes within departments of transportation, both state and national levels, and better information to political decision-makers. This, of course, is key. Just as an aside, if the Senate reorganization plan goes through, I think you will see that Congress is better equipping itself to deal with transportation planning on a more balanced and comprehensive manner. Balanced transportation planning, which is our dream, requires (i) a realignment of current funding, subsidization, and regulation programs; (ii) elimination of the trust funds (the highway and the airport are at the top of our list here); and (iii) elimination of subsidies for environmentally damaging modes of transportation. For example, we need to curtail future expansions in the barge-canal projects and huge new highway projects and to impose waterways and road-user fees.

I think the fact that Sierra Club is a co-plaintiff in the Lock and Dam 26 suit says enough about how much I would have disagreed with what Mr. Hershey had to say. And, similarly, our participation in numerous highway suits reflects my disagreement with what Mr. White has said. I am reminded of the article that appeared in the Sierra Club Bulletin a couple of years ago; perhaps some of you will recall it. It was a spoof article entitled "From Sea to Shining Sea." It purported to tell the public about a cross-continental barge canal, and it was subtitled "Or Through the Rockies at 31 Knots." This created great consternation among people, especially the people who took it seriously. [laughter] We had many irate members calling up saying, "What is this?" They were more irate when they found out that we had been pulling their leg and that they had taken it seriously.

We do advocate government assistance for more environmentally beneficial transportation modes, primarily, the railroads. We really see the railroads as being probably the most environmentally beneficial mode of transportation, and we are eager to participate in helping with the revitalization of the railroads. Now I realize that that may not cause handsprings among railroad people. They may say, "With friends like you, who

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Ms. Billings has been representing the Sierra Club before Congress and federal agencies for close to four years. Her special areas of concern have included transportation issues, land preservation, pollution control, energy, and health safety.

needs enemies?" But we do see them as being very important, and there is an increasing attempt to better inform ourselves about what is needed to improve the railroads' system; we plan to focus on that more and more. We expect to see, for example, increased interest in ways to improve road beds and more support for research and development as well as innovations and ways to stimulate more capital. In all of these, we feel the government does have a role to play.

I am mindful that there are problems with railroads. However, this illustrates the importance of balanced transportation planning at the regional and national levels so that we can have a better idea of what the trade-offs are in terms of the benefits and the problems with regard to a particular transportation mode. With planning, we can better decide whether improvements in an existing transportation mode can better suit the needs of that region or that particular segment of the industry, or whatever, rather than going into expensive new public works projects and such. Furthermore, we do very much see the importance of regulatory reform to the future vitality and improvement of all of our transportation systems. And I think you will see increasing support from the environmental community for deregulation or regulatory reforms in future legislation.

We also need to have better coordinative planning with regard to other national programs, such as housing and energy, and urban revitalization. I believe that the urban revitalization is a future trend and that improvements in intracity transportation will play an important role. I think you will see increased interest in solving the problems of congestion, noise, and air pollution, and in the necessary technological advances to solve those problems.

Energy problems will also be an impetus to future technological improvements. I don't recall any mention during this conference of alternative propulsion systems, other than shifts from petroleum to coal. What about other fuel sources? Here I believe that government will have to take a leading role in encouraging R&D efforts and technological developments in producing alternative engine propulsion systems for passenger and freight vehicles such as electricity or steam, for example. Some references have been made to the importance of melding transportation and energy policy planning. Other references have been made to trade-offs between clean air and energy efficiency. This is probably too simplistic. Furthermore, sacrificing clean air is not an adequate substitute for an energy policy, especially when we see the gains which can be made through energy conservation.

Finally, I heard practically no reference to technological improvements in safety, especially with regard to the transportation of hazardous materials, such as chemicals and petroleum. This is essential, and I hope that, even though not much mention was made to it, that this is indeed an important part of the transportation R&D efforts of all modes.

I would like to close with the comforting thought, though, that as we see increased focus on transportation among environmental groups, it will be accompanied by a great deal of internal conflicts and dissension and debate. I think certainly some of the internal debates that have come up over, for example, cold slurry pipelines versus railroads is one example. But I would just like to leave you with the definition of progress which many of you know: "If for every solution we can encounter a new and different problem, we have the illusion that we have progressed."

DISCUSSION PANEL

"A CRITIQUE OF PROJECTED TECHNOLOGICAL RESPONSES BY VARIOUS MODES"

Remarks by
R. V. Durham
Director of Safety and Health
International Brotherhood of Teamsters

I am very pleased to be here this afternoon to discuss and assess the potential for technological advances in intercity freight transportation in the 1980's and 1990's. Representing the International Brotherhood of Teamsters, with a membership in excess of two million workers, I can think of no group that is more affected by technology than the drivers we represent in the freight industry. I suppose that the bottom line in technological advances is an assessment of increased productivity — the ability of intercity modes of transportation to distribute the nation's goods to an ever-increasing population throughout this vast nation of ours.

Looking back to the beginnings of movement of freight in this country, the advances in technology have been rather obvious. We went from the horseshoe to the hard rubber tire to the inflated tire. We went from oats and hay as a source of energy to gasoline and now to diesel. We have seen the advance from one horsepower to the huge power plants that move upwards of 80,000 pounds of freight on today's interstate highways.

Frankly, we do not know what lies ahead and I suspect that we are in a rather large group in that regard, supposing only that, as supplies of traditional energy become more and more in short supply of necessity, we will need to find alternative sources of energy to fuel the tractor-trailer rigs which move the nation's freight today. Frankly, we and the Teamsters are not technicians or engineers. I'm a truck driver myself who has been off the truck about 16 years, representing the drivers and so forth. But while our drivers are often the beneficiaries of advanced technology, oftentimes they are also the victims. The increased power plants have made our chore of moving the nation's freight an easier task. And, as our drivers are paid by the mile, the increased power has also increased our earnings. Power steering, air conditioning, interstate highways, and so forth, to name a few, are technological advances which have made our task easier.

But all too often such advances have overlooked an area of deep concern to us: that is the job safety and health of our members who drive these units over the highways. The cab of a tractor today is an unhealthy environment. It is unhealthy in terms of fumes which permeate the cab and the lungs of our drivers. Noise levels impair the hearing of the drivers. Constant vibration is causing serious health problems. To illustrate the problem, those of you that rode over on the bus this morning and were sitting over the wheels can appreciate the problem riding in these truck cabs four and five hundred miles a day under those conditions. You can see what the problem is there as far as vibration. These trucks are not being built for comfort. They are being built to haul freight, and they are jolting our drivers' insides and spines and so forth, causing a serious health problem.

In states where the option for increased weights to 80,000 pounds have been exercised, our drivers now face the potential for danger. While we in the Teamsters do not oppose increasing weights from 73,000 to 80,000 pounds, we did lobby hard and long to have Congress place restrictions on the increased weight on the steering axle for obvious reasons. We lost that battle, but we're still fighting to win the war. We do not oppose increased productivity when safety precautions are considered. Since the acts of Congress left increased weights up to the states, we now have a situation where it is impossible for an interstate carrier to travel with the 80,000 maximum across the country. From Mississippi on the extreme south to Minnesota and Wisconsin on the extreme north, a barrier exists which still opts for the 73,000 maximum.

What we are proposing is that the nation adopt a uniformity of weights, lengths, and heights on tractor-trailer rigs, and, I would emphasize, with concurrent safety requirements, such as proper placement of the fifth wheel or coupling device to insure that the steering apparatus and the front tires are not overloaded. We in the Teamsters are in full support of such safety devices which are advanced technology: anti-lock systems, air-conditioning the cabs, elimination of cab-over-engine tractors, and driver seats which overcome constant vibration and resulting injury to body organs and the spinal structure. We realize full well that such requirements directed to the safety and health of the driver are costly items. On the other hand, we have not been able to compile a list of items which are free in this day and age. We're aware that increased productivity must address itself to the safety and health configuration as well as addressing itself to such items as speed, greater

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In addition to serving as director of safety and health for the Teamsters, a position he has held since 1973, Mr. Durham is the president of Teamsters Local No. 391 of Greensboro, North Carolina.

weight, and whatever the engineer and technician might devise for the future.

I might inject at this point that there are barriers to increased technology in the movement of intercity freight over and above what I have outlined in the safety and health area. One, which I am sure is obvious to this group, is the proposal to deregulate the trucking industry and other forms of transportation. Obviously, we oppose transportation deregulation because of the effects it will have on the wages, hours, and working conditions of the drivers we represent. In a broader perspective, we oppose it because of the denial factor; that is, a curtailment of trucking service to smaller communities, as carriers would seek only the most lucrative routes. Advanced technology and increased productivity can only come in some semblance of order and regulation.

Another area of concern, I believe, is in the area of public acceptance of larger and bigger trucks on the highways. The motoring public, and I'm sure all of you are aware, accepts all of the conveniences provided by the best trucking system in the world and yet cusses every truck on interstate highway. So I suggest that those who search for better and more sophisticated technology in the intercity freight movement in the 1980's and 1990's had better be public-relations-minded. It will be necessary to gain acceptance of double-bottoms, for example, in much of the eastern part of the country. We are told, and we have no reason to doubt the premise, that the day of mass paving of the countryside with concrete interstate is over. In the next two decades we can expect that the increased productivity in the movement of intercity freight will be done on existing roads and highways. In short, we will have to make better use of what we have through such exercises as increased weights and lengths.

I suppose that advanced technology in medicine will have some effect on the life of the drivers (as it will have an effect on everyone) and many illnesses will be cured. But in his particular and peculiar environment in the cab of a tractor, technology will need to pay particular attention to the driver because the bottom line is — no matter how advanced the technology becomes, as we understand it today — a driver will finally have to get behind the wheel and take intercity freight from one point to another. If we pay attention to his needs of a safe and healthy environment, he will probably be the most important factor in increased productivity. If we ignore those important needs, we'll undermine the creations of engineers and technicians in a simple, logistic sense. And, in an area which is often overlooked in a profit-oriented society, we will have failed in our moral obligation to humanize technological advances.

As I mentioned, I tried to be as brief as I could. I would like to take a couple of minutes, with the chairman's permission, to offer a couple of points on some of the comments that were made by the earlier speakers. Secretary John Barnum stated this morning that some of the areas of promise in truck transportation are larger and heavier trucks. As you have already heard me comment, we do not disagree with this, provided considerations for safety are included. I do not agree with his suggestion that we will have truck-trains pulling 12 trailers down the highways. I think there is room for double-bottoms or twin trailers, but when you start getting into triples and three trailers or more, I question the feasibility, safety, and so forth. But, in addition to that, I think that we've got to have a few other considerations, which would include increased horsepower weight ratio for uphill performance. You know, it is one thing to have a tractor pulling 70,000 pounds, but when you go up to about 120,000 pounds gross, as I have read just recently they are talking about, you have got to have larger power trains there to carry the weight.

We need improved braking, even beyond the 121 brake system, which has become very controversial, to say the least. We will need improved federal and state enforcement of the commercial vehicle safety regulations. In addition, I think one of the most important things is that we need to get away from the concept of overall vehicle length restrictions and give consideration to length restrictions on the cargo-carrying container only. This would permit the engineers and the technicians to design a truck cab that would be safe on the highways and would also give the driver a decent piece of equipment to pull the longer, heavier, higher, and wider trailers that are now being discussed.

Secondly, Mr. Barnum stated that, in his opinion, you could not have technological advances without deregulation. I disagree with that statement completely. To accept this premise is to say we have not made technological changes in the past under the government regulations that we have currently. I would submit that we have made technological improvements and I would suggest we can continue without deregulating the transportation industry.

I agree with Mr. Johnson's (Sears) statement that we need to come to grips with the problems that we have today before we look too much into the crystal ball. I am not sure that he stated that exactly that way, but that is the drift I got from his comment. I also agree with him on the concern of the cost of fuel. He said that one cent increase in the cost of fuel increased, I believe, their shipping costs one million dollars. This, I think, highlights that there is a real problem.

I know Mr. White, with Consolidated, and Dr. Meyer, I believe, stated that there should not be that much concern. Just a couple of years ago, if you recall, when the price of oil went up, I'm reminded that there was a 6 percent surcharge added to freight shipping charges. That tells me that it does play an important part as far as the cost of shipping as we understand it today, especially in truck transportation.

I found Mr. Freitas' article in the book that was passed out to you today very interesting. I think it starts on page 237 and it deals with FHWA research efforts. I would like to read one part of one paragraph to highlight what I've attempted to point out here this afternoon. This makes reference to the decision that was made by Congress in 1974 to increase the truck weights from 73,000 to 80,000 pounds. It is said, "At that time," and I'm quoting from the article now, "Congress was once again considering a change to allow the states to increase their weight limits on the Interstate System. The Federal Highway Administration supported this legislation as a method of counterbalancing the negative impact of the 55-mile-per-hour speed limit on the trucking industry. During Congressional hearings it was apparent that the matter of most concern to Congress was not the effect on the highways, the effects on the trucking industry or the national economy. Their major concern was safety, yet the safety consequences were what we knew least about."

I appreciate your time in giving me this opportunity to speak to you this afternoon.

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Question: Of the several statements that you mentioned, which are matters for government regulation and which are matters for negotiation between the union and management?

Answer: Well, I would suggest we have a bleed-over there. We negotiate, for example, on safety and health. But, at the same time, we turn to the government agencies for them to do their part on safety and health.

Question: Do you negotiate on weights?

Answer: We do not negotiate the question of weights in our contract. That is left up to the state involved.

DISCUSSION PANEL

"A CRITIQUE OF PROJECTED TECHNOLOGICAL RESPONSES BY VARIOUS MODES"

Remarks by
Dr. William Harris, Jr.
Vice President
Association of American Railroads

I think I am one of the very few people who will be speaking to you today or tomorrow who actually has a line responsibility for managing a research program; so I would like to try to put in context of my operations some of the things that have been said today and offer you some additional remarks.

The essential problem in managing a research program, or managing anything for that matter, is deciding how to create an adequate resource base and how to allocate those resources. In the six and one half years I have been in the industry, I suppose I've spent almost as much time trying to create a resource base (working with my friends in the industry and my friends in the government) as I have in determining how to allocate those resources. We do not have, in my opinion, an adequate transportation research resource base in the United States. In some various areas such as aircraft structures and aircraft power plants, we may have adequate programs because of the multi-institutional interest, the Defense Department interest, as well as the transportation industry's interest in those programs. But in a great many areas – such as the upper limits of loads in relationship to the roadbed, whether it be rail or highway, and the upper limits on safe operating speeds and on reliability – we confront technological and non-technological issues which have not been adequately addressed either by the academic community or by people engaged in research in industry or in government.

I think we have a collective responsibility to try to ensure that that resource base for doing transportation research is in fact expanded, in order that transportation in the United States can continue to improve. All of us are convinced that the United States' economy, more and more in competition with other economies in the world, cannot afford an inefficient transportation system.

In terms of the processes of allocation of resources, we have a very different problem in the United States than in some other countries in the world, particularly those which have a more managed economy or a more nationalized set of transportation systems which can be directed and can be assigned roles and missions. In this country, of course, we have a highly competitive intermodal, multimodal set. I think that is a very desirable circumstance. But that circumstance makes it very difficult to decide how best to allocate the limited resources we have for research. The modal choice decisions made by shippers from whom all of us have a derived demand are based in part on cost, in part on reliability, in part on speed, in part on issues of loss and damage. The kinds of research one does for each of these is really quite different. Some initial judgments must be made as to what a given mode is required to provide by way of service. This judgment defines areas of research that address three issues.

Only recently have the societal issues of environment and, in some senses, safety reached the levels of concern that we all observe today. In our research program, we have seen a major impact of those concerns. Indeed, we have substantial activities – often cooperative with government, including the EPA – to explore and establish the environmental impact of the rail mode, and the options open by way of immediate corrective action. I think those environmental concerns are going to be with us forever. I think we have no choice but to respond as efficiently as we can to them. We have to try to continue to ensure that adequate analysis is performed so as to try to make some cost-effective decisions. I know the cost-benefit issue has been drawn into the area of safety. Very recently the Washington Post had a long article concerning the Council on Wages and Prices and certain EPA actions. The Council charged that specific decisions had a very small impact on the environmental issues but were exceedingly costly. We have to be prepared to develop the methodology and the tools so as to subject all of these issues to rigorous analysis because we cannot do all the things that we would like to do.

The railroads have been committed to safe operations for a very long time. All railroads have operating manuals and most have improved training programs attempting to ensure employee safety. But, again, the societal concern with the movement of hazardous materials has surely focused our attention. I have in my hand a regulation published Monday of this week by the Department of Transportation which stipulates changes in the design of tank cars, pursuant to a research program we started in 1970, and were joined in by the FRA a couple of years ago. I am confident that the change in design of the tank cars called for in this

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Dr. Harris was named Railroad Man of the Year for 1976 by Modern Railroads magazine. He is presently chairman of the Special Committee on Rail Transport Activities of the National Research Council's Transportation Research Board.

program, though it will cost about $200 million for retrofit, will improve significantly their resistance to damage in accidents. And I can say to you then that there has been a real success. This was an industry-initiated program, obviously stimulated by very real government concern.

One other matter that has not been touched on today is the impact of legal proceedings on societal concerns and the ability of our industries to provide effective transportation. The legal issues that arise as a result of third-party liability suits are increasing greatly. I am appalled at the extent to which every lawyer finds dozens of people to sue. In one highway - tank truck incident last year, suits in an amount over $150 million have already been filed. While I certainly understand the right of people to search for the guilty party, I believe that the third-party liability issue has gone far beyond a reasonable level. We are not going to be able to utilize our resources efficiently and effectively if this trend continues. It already has deflected a substantial part of my research program and my own time to relatively trivial problems.

I support entirely what Mr. Ingram said earlier. Up to about 1900, the railroad industry was, in fact, the driving force in technological development in the United States. Many of the great engineering schools in the Midwest came into being as a result of a requirement for steam tables, braking systems, and improved materials. The technological advantage that was created allowed the industry to turn away from technological advance, although minor iterative improvements continued to be made. Until the interstate system allowed the trucks to be much more competitive, the railroad industry was preeminent in ground transportation. To meet the competition, changes were made to achieve certain economies of scale, but those decisions exceeded our ability to extrapolate. As a result, we now face real problems. These require us to create a basis for scientific evaluation of those decisions and of alternative, improved practices.

We were fortunate, when this program started, to have a rather extensive base of defense and space-derived science: computers, analytical tools, some advances in materials research, and so on. But, in a matter of only five years, we have outrun the capability of those kinds of tools to serve our problems. We are now faced by a requirement to press in more rapid developments in the science and engineering of wear, of non-linear behavior, and plastic-elastic interface problems. We are pressing the horizons of science. I am pleased with this change, but also frustrated because it will be difficult to make advances in technology in those fields.

It is quite clear that improvements in railroad productivity are mandatory. Those improvements in productivity are going to grow out of work on the system side of the house. And much of that system side of the house impinges in an important way on our relationships with labor. The agreements that have been negotiated in collective bargaining present problems with improving productivity. We have a number of programs in cooperation with the Brotherhoods in which work agreements are set aside for trial periods of time so as to establish their impact on productivity. The findings of these experiments are used by the negotiators in arriving at more satisfactory work rules.

There is a very important role for government in transportation research and in railroad-related research. I have been working with Jim Costantino, Ham Herman, Bob Parsons, and Ed Mathews of the Transportation Test Center on the roles of our respective organizations. We are working toward an adequate level of communication about our problems for use by people in government who will be carrying out or planning research and toward an adequate flow-back of information on their findings so that we can put research to good use. There is a role for suppliers in research, but our cyclical ordering pattern (where one year we may have orders for 90,000 freight cars and two years later, almost none) makes it very difficult for continuous support by the supply industry of an effective research program. And, of course, there is a role for the railroad industry and for the AAR in research, but that role will change as the size of the programs changes.

We have opportunities for improved technology. My concerns about this conference, which I expressed to the distinguished chairman, was in fact my fear, however, that there might be too much emphasis on technology. But I have been just delighted at the fact that people always, in every speech, have put technology in the right context. Technology is not necessarily the end-all be-all of improvements in transportation. There are many other areas of research and many other kinds of research that are very important to pursue.

DISCUSSION PANEL

"A CRITIQUE OF THE PROJECTED TECHNOLOGICAL RESPONSES BY VARIOUS MODES"

Remarks by
Edward V. Kiley
Assistant to the President
Policy, Planning and Development
American Trucking Associations, Inc.

Good afternoon, it is nice to be with you. I have got a little bit of a problem here. I had understood that our panel's comments would be on what was discussed by the prior panel. I didn't like that, but I felt, "Well, that's the way it is, and that makes sense." But what I did anyway, early in the day, was to make notes of what other people had said starting at the beginning. My mouth began to water as certain things were said, and I thought, "I'd like to comment on that," and so I made my notes. Now I understand the subject is wide open, but now I can't read my notes. But I would like to make a few comments on what some of the earlier panelists said, and I'm going to start with John Barnum.

I can appreciate John's swan song on motor carrier deregulation. I guess I'd do the same thing. You have to make one final pitch even though the corpse is in the casket. But I would take serious issue with him on one thing, and I have argued this with him many times over the past two or three years. Obviously I haven't gotten anywhere – I have not changed his mind. He indicated that regulation of transportation was not justified because it is not a public utility. Therefore, I would draw from that that you regulate public utilities and you don't regulate industries which are not public utilities, or quasi-public utilities.

So the question is, "What is a public utility?" We have maintained that transportation is a public utility because it highly affects the public interest. The people at DOT, and in other areas who argue the other way say, "No, the criteria is 'threshold costs.'" Now my background is economics, but these new terms elude me. I mean, I can't interpret them sometimes. I don't know what they are saying. They talk about "threshold cost." We used to call it "initial capital investment," so I don't know. "That's the criteria," they say. "It's how much money it takes to get into the business." I say, "Well, that's fine, then let's regulate the automobile industry, let's regulate the steel industry, and the petroleum industry, and the aluminum industry." "Oh, no," they say, "they're not that affected with the public interest." So that is what I want to talk about.

I argue with John on that. I say to him – he's not in the room now, but he knows as I have said this to him before – I say, we need regulation of transportation because it does affect the public; it is related to the public interest. If it is not, then we don't need the ICC; we don't need a Department of Transportation; and we don't need this 60 million dollar transportation center here. The only reason we have these institutions is because we are talking about an industry that does affect the public. So, John, I don't agree with you and I don't buy your approach.

There are a few other points I would like to make on comments that were made earlier. I did not want to take issue with any of the panelists that appeared earlier. And certainly I didn't think I would have to take issue with the pipeline panelist. I don't think in our industry we have had a single argument with the pipelines. But I do have to take issue with Tracy Park on that chart he showed about the relative efficiency of various forms of transportation. For heaven's sakes, Tracy, you know a lot better than that – and I could have given you a much better chart to prove your point. But I raise that because we have been fighting this battle with these "academicians" (I got that one out pretty good), with the people in government, over these comparisons of statistics.

To say that one form of transportation is more efficient than another because it can move a ton of freight one mile for less use of fuel is completely ridiculous. What are you comparing? Now if he wants to compare the movement of coal by pipeline or oil by pipeline with the movement of coal or oil by water or by rail that's fine. But to put the trucking industry up there – when the vast majority of our revenue comes from shipments weighing less than 1,500 pounds and moving less than 325 miles, and when the entire burden of transportation in this country of small shipments is falling on our industry – to measure that on a fuel use ton/mile basis is ridiculous. Let me tell you how ridiculous it is. It is almost as bad as a study made by the National Transportation Safety Board about two years ago on the relative safety of various forms of transportation. Now you are not going to believe this, but I can send you the report. They were computing the fatalities of people involved in highway transportation per ton/mile of freight moved over the highway. Now the fatalities included everybody that was killed on the highway in a vehicle accident. They showed the fatalities on the railroads per ton/mile of freight – per ton/mile of freight by air, water, pipeline. The safest was pipeline. Well, I say to you, if you're concerned

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A regular lecturer at the Department of the Army's School of Transportation and the Industrial College of the Armed Forces, Mr. Kiley has been on the ATA staff since 1948. He is a founding member of the American Society of Traffic and Transportation.

about your safety, you travel by pipeline. So please, let's use figures that fit the facts.

Now, just briefly, a few other things. One is that we seem to have swept this fuel problem under the rug. Maybe I am looking too far in the future. But keep in mind that surface transportation in this country (all domestic transportation as a matter of fact, but I guess all intercity transportation) is now bound in to the internal combustion engine, and bound in to diesel fuel. There is no foreseeable alternative at the present time. Now maybe here again I am looking too far in the future, but remember this: no matter what we do to improve that engine, no matter what we do to develop new fields, we're dealing with a depletable resource. There is nobody down there making more petroleum. When we get what's there, we have had it. There are no little people down there turning coal into oil, or whatever is done.

So, we have got to move ahead on a replaceable source of fuel. I think out there somewhere there is a new source of power for the internal combustion engine. Those who say, "Well, no, there's no way of getting it, that's an impossible dream," I will remind you of this (most of you here, your memories won't go back to this, others will): before World War II, we saw the loss of our rubber supplies. Mr. Ford, Henry Ford, saw it and tried to develop rubber plantations in South America. We felt, "My God, we're going to lose our sources of rubber. What are we going to do? There's no way we can do it!" But, in two years we developed synthetic rubber.

Just a few other points . . . Looking to the future, for the productivity of transportation, I would emphasize two things. One is, let's get this interstate highway system finished. I think one of the most deplorable things in our transportation picture from the standpoint of efficiency is the muddleheadedness that has led us to stall this system. The money is there. It has been there. The system should have been finished a long time ago. It was a great tragedy that a 42,500 mile system of badly needed highways, which has done more to save lives than any single program in transportation in the country, has been stymied because less than 1 percent – less than 1 percent – of the mileage became involved in local political controversy. Because of that, there was a plague on the whole thing. Let's get it moving; let's get it finished. The money is there. Let's move ahead and get it finished. And, while we're getting it finished, let's recognize the potentiality in transportation efficiency in our bringing up to the new allowable federal limits state laws to permit these trucks to operate at more productive gross weights. Bill White said that's where the productivity is. As we say in the trucking industry, "The payload is the payoff." Let's move ahead on it.

Now, before finishing, there is one point here that I didn't see emphasized too much which concerns us in the trucking industry, particularly from the standpoint of the proposals to deregulate our industry . . . proposals we hope now are slumbering peacefully in the casket. (But nothing ever dies in Washington; it so often comes back in a different form.) No one has mentioned the threat in the closet of nationalization of our railroad system, which is still there. For example, what are we going to do with Amtrak if it doesn't work. Will we continue to pump federal funds into it? What's the difference – if the federal government runs it or pays for it – what's the difference? What happens to Conrail if it doesn't work out? Let's hope it does work out and we don't nationalize our railroad system. Now you might say, "Well that's a funny statement coming from a spokesman for the trucking industry." Well, I admit we have had our running battles with the railroads over the years; we'll probably have some more in the future. Some of them have been a lot of fun, some have been bloody. But, nevertheless, we don't want the railroads nationalized. If the experience in other countries in the world is any indication, if we nationalize the railroads in this country, the future of the trucking industry is bleak, indeed.

So we do not want it, and it doesn't have to happen. But I would tell the proponents of deregulation, "Stop working in a vacuum. Deal with it as a system. And take a very good look at your proposals on deregulating the trucking industry and see what they will do to the railroad industry."

I will tell you what I think it will do to them, but you don't have to take my word for it. Ask the railroad industry and they'll tell you what it will do to them. Back in the late 1950's, there was a very comprehensive study made of the entire transportation system by the Senate Commerce Committee, or rather for that committee. They pointed out in the report a very important fact that has not changed: whatever we may do in transportation, the backbone of our transportation system in freight is the common carrier, and it will continue to be the common carrier. If he cannot perform the service necessary for our transportation needs, we will have a collapse of the system. They pointed out then, and I think it is true today, the greatest threat to the ability of the common carrier to function in the public interest, be he water, air, motor or rail, is the growth and the extent of transportation not covered by economic regulation. Keep that in mind, believing it or not, and go back, analyze the DOT proposal for deregulating the trucking industry and say to yourself, "What will this do to expand exempt transportation?" I think the answer will be obvious.

One final comment – in a way, it's sort of coming in on the reverse of what Bill White had to say about their company's use of piggyback. I think that's the experience for many motor carriers. I have also had the question put to me, "Why doesn't the trucking industry use containers more?" I've said, "Well, to my knowledge, and I've talked to carriers, if the shippers want them, we'll use them. You give the shipper what he wants and you'll succeed." Now, reversing that in conclusion, I get concerned about all these proposals about changing transportation, changing the rules, changing the regulations, or completely deregulating. They seem to come out from studies which go to diagrams and charts and maps and books. They say, "Well, now, I don't care what you're doing over here in reality, here's what it says in the book. And here's what this chart bears out up here. And this is the way it ought to be." They don't want to talk about the way it works. Reversing that reminds me of the old dog food story. You know, this big dog food company is having their big annual meeting with all their salesmen, and the president is saying, "Now, gentlemen, who makes the best dog food in the world?"

"We do!"

"Who has the best packaged dog food in the world?"

"We have!"

"Who's got the best sales force in the world?"

"We have!"

"Who's got the best public relations program in the world?"

"We have!"

Then the president says, "All right, why aren't we selling more dog food?"

Silence. Suddenly a hand goes up in the rear. "It's those stupid dogs. They won't eat it!"

DISCUSSION PANEL

"A CRITIQUE OF THE PROJECTED TECHNOLOGICAL RESPONSES BY VARIOUS MODES"

Remarks by
Peter Albert
Vice President
Shulman Air Freight, Inc.

Air freight — is the problem technology? I'll let you decide. We have been forecasting air freight since its inception. These forecasts were to a great extent based on new aircraft and reduced ton/mile cost. We have discussed the revolution of air freight and what this would bring to transportation. And what happened to the revolution?

In 1934, the tri-motor became an obsolete passenger airplane and was converted to a freighter; that was going to be the beginning of the revolution. Then at the end of World War II, we had the beginning of modern air freight. What was it we said in the early 1950's? "This was the industry of the future." We then forecast a 20 to 25 percent increase every year. In fact, in the beginning, that's the way it was. We then went through the Bud-Conestoga, the C47, the C46, the DC4, the DC6, the 1049H Constellation, the CL44. With the advent of each new aircraft we said, "This new aircraft is the key. Now we'll have the revolution." We heard forecasts that 5, 10, and 15 percent of all U.S. traffic intercity would move by air, excluding perhaps only the bulk commodities. And in the beginning, we thought we were right. We said this in 1952, that less than 1 percent of intercity traffic moved by air.

Then in 1958, along came the jet, and we said, "Now, with the advent of the jet aircraft, with the reduced ton/mile cost that we'll have, this aircraft would bring the revolution." Today, 25 years later, we are still talking about the revolution of air freight. And yet, 25 years later, we still transport less than 1 percent of the intercity ton/miles.

Clearly, the problem is centered around economics on several fronts. For one thing, economics has contracted the scheduled air service network. In 1956, the trunk and regional carrier served 677 cities. By 1966, 140 of these cities had been wiped off the airline map. This year, 1976, another 100 cities will be left out in the cold. Our current list of service points is getting down to 437, a 35 percent reduction in 20 years. Truly, it is getting more difficult, if not impossible, to get there from here. That difficulty is particularly tough for air freight shippers. The largest single benefit we as an industry offer is speed. Yet our door-to-door speed is being progressively slowed by reduced geographic coverage. Air freight moves at night. Passengers move during the day. The answer is not more capability with combination aircraft that fly during the day.

Back in 1951, when I started as a salesman for Flying Tiger, Joe Healy, currently executive vice president of Flying Tiger, and I had a very difficult time selling air freight against the competition we had in those days because we only offered second-day service. Today, second-day service is the rule in most of the major points. We cannot consistently regress in our industry, but we must move continually forward in service and in pricing. Since April 10, 1974, we have seen a 115 percent increase in air freight pricing in the United States, and yet the bulk of the traffic is being carried in the belly compartments of passenger aircraft.

Concurrent with the reduction in airport coverage, the economics of modern aircraft has generally caused airlines to delete short-haul service. It is simply easier to make a buck flying 2,000 miles than it is flying 300 miles. The L10 11's, the 747's, and the DC10's are just simply more efficient at the longer stage lengths. Cargo and its potential has been the stepchild. All-cargo aircraft, which only six years ago were providing service to 50 cities with prime-time service, are now reduced to just a dozen cities in the United States. And 80 percent of this all-cargo lift in prime time serves only four cities: New York, Chicago, Los Angeles, and San Francisco. And I wonder if this is a cargo system.

I could go on with statistics all day long, but I think the picture is clear. Certainly it is for air freight forwarders like Shulman and Emery Air Freight. We have been forced to charter aircraft of our own in order to serve our customers. Even so, I have used such chartering, certainly, as a temporary solution at best. We at Shulman are certainly not in the airline business, and I'm sure John Emery would agree with that position. Parenthetically, I would note that these temporary band-aids provide absolutely no military support in the event of a national emergency. As Chairman of the Board of the National Defense Transportation Association I also have a responsibility to address this problem. We do have a Military Airlift Committee, in which Charlie Baker and General Carlton, the Military Airlift Commander, are hard at work on the problem today.

Mr. Albert has 25 years of experience with several companies in the transportation industry. Currently, he is serving as chairman of the National Defense Transportation Association.

We have got to create the economic incentives for development of all cargo aircraft and their true utilization in a national system. We must have the all-cargo aircraft for both U.S. commercial use and military preparedness. The technology is there. In point of fact, no revolution is required for the introduction of a cargo aircraft for both military and commercial use. The technology is here today. Only economical incentives are lacking. Cargo is not that particular about the size or type aircraft it is riding on. It's not overwhelmed by service quality such as quietness, or newness, or other quasi-emotional qualities. It only wants to get where it's going quickly.

I certainly don't mean for a minute to minimize the seriousness of the current airline economic dilemma. Indeed, I would strongly advocate measures to make available to commercial airlines financing in quantities sufficient to reestablish this cargo fleet. We must have the all-cargo aircraft if this industry is to grow in the United States. I noticed in the statistics in the trade presses in September that during the month of September 1976, while passenger traffic grew by more than 17 percent, domestic air freight ton/miles grew by only 1.5 percent. International air freight increased only 2 percent, as compared with September 1975.

We are seeing the U.S. air freight industry literally being choked by the lack of units of production, namely freighter capacity. The ironic part is that the carriers I have talked to generally agree with this view. Their response is one that I certainly sympathize with. The capital is simply not available at this time to enable a cargo aircraft commitment.

I do have two suggestions for a solution. Certain carriers with all-cargo aircraft should be allowed to broaden their scope of activity.

It seems clear to me that we must immediately move forward towards a federal government assistance program. This would not be a subsidy — and, certainly, would not be an operating subsidy. Rather, this would involve a construction-assistance program that would enable carriers to work with manufacturers and with the military in order to develop and build a family of compatible cargo aircraft. By providing some construction assistance, only funds would be made available for new cargo aircraft. Yet operating restrictions, which so inhibit maximum flexibility and utilization, would be minimized. Competition would not be limited. Service and rates would, therefore, become functions of the free market.

I certainly do not advocate an Amtrak of the sky. At the same time, with the means to provide service available, the pressure upon prices, pressure which has resulted in premium pricing for less service than we were getting 15 years ago, would be minimized. Specialists in the handling of freight, specialists whose economic existence would be a function of their ability to handle freight profitably, is what hopefully would result. Disfunctional proposals, which effectively inhibit the growth of air freight, now would no longer be justified. I am thinking particularly along the lines of a recent rule change by some of the direct carriers concerning hazardous material. Here is a market that required the services of air freight. But, in fact, it did require cargo aircraft, and in many cities we did not have the cargo aircraft available.

The second recommendation for action is to increase the cities served with cargo aircraft by those carriers that can plan to implement this cargo service immediately, regardless of their present certification. Several years ago, an all-cargo airline applied for rights to a major city in the Southeast. Immediately following their application, the combination carrier with rights to that city put in a cargo flight to that city. Some 90 days after, the hearing was terminated that determined that there was sufficient cargo capability; the cargo aircraft was withdrawn, and today we do not have cargo service in that city.

My proposal is that the all-cargo carriers who are presently certified, or, in fact, the combination carriers who hold certificates for common carriage, should be allowed to provide all-cargo service to additional cities under an immediate waiver from the Civil Aeronautics Board. If any certified carrier feels that they can enhance their business in the industry by serving additional cities with all-cargo aircraft, they should be allowed to do so immediately and not be involved in a multiyear proceeding that would deter their efforts in the industry.

With those remarks, I conclude with this. I have spent my entire career in transportation, and most of it in air freight. I know that we can solve these problems that are facing the air freight industry today, and the proper economical incentives must be provided. I am sure, as we have in the past, we'll solve our current problems and hopefully in the immediate future.

Richard L. Terrell
Vice Chairman
General Motors

Mr. Terrell, who has general responsibility for the Operations Staffs at General Motors, is vice chairman of the Executive Committee, a member of the Finance Committee, and a member of the Administration Committee. He joined GM in 1937 as a member of GM Photographic in Detroit. Prior to his nomination to vice chairman in 1974, he served as director of General Motors and executive vice president in charge of the Car and Truck and Body and Assembly Divisions Group of GM. A member of many business and professional organizations, Mr. Terrell is on the board of directors of General Mills and is on the board of trustees of the University of Dayton and Wilberforce University. He is also chairman of the Board of Regents of the General Motors Institute.

DINNER ADDRESS

"TRANSITION AND CHALLENGE"

It's a privilege to be here. Accepting Charlie Baker's invitation, and noting some of the thorny issues, I saw the wisdom of the approach he chose when he spoke recently – and eloquently – on forces of change in transportation. That approach, which was to provide more questions than answers, is appealing in addressing the topic of this conference: "America's Freight System in the '80's and '90's . . . but how to get there?" For if I had the answers, if any one of us had, we might dispense with conferences like this. And the National Transportation Policy Study Commission could forgo a big chunk of the work it has been given the next two years to complete.

Yet notwithstanding some differences of viewpoint expressed here today, and anticipated tomorrow, it seems to me that the answer is essentially something like this. Considering freight systems for the 1980's and 1990's in the context of economics and social concerns, advance is more important than breakthrough. For I think the barriers to having the improved freight systems we want and need are clearly more economic and institutional and societal barriers than they are technological. This is true also, for example, of the improved intercity movement of people and of better urban public transportation – equally important but not our themes of the moment.

Every issue does not reduce to a technical problem with a technical solution.

Freight movement, at least for the next couple of decades, will depend largely on the same modes, the same kinds of vehicles, craft, and systems, that are moving the nation's goods today. Better freight systems probably will not be – and need not be – fundamentally new or different systems in the time frame we are considering.

The challenge is to improve on and make better use of what we already have – to do better what we already know how to do, for the most part. On land, for instance – and these are the modes General Motors is most identified with – we don't think 20th Century America is going to see the wheel re-invented or replaced. That goes for the automobile, too – but that also is not my theme, directly.

The perspective I would bring to this conference is a two-point perspective: that of a user and a supplier of freight transportation. While General Motors is not unique in this, our perspective probably may be considered unusual in the extent of our involvement in both of these roles.

On the manufacturing side, we are the major supplier of diesel locomotives, and newly entered in the electric locomotive business. Having been a part of the locomotive business so long myself, I am pleased that our Electro-Motive Division people are among those invited to make technical presentations at tomorrow morning's conference session. We are also a major supplier of trucks — the cleaner, quieter, more fuel-efficient trucks the times require. We manufacture stationary diesel engines and marine diesels and aircraft engines as well — having some part in supplying just about every segment of the nation's freight network. And we have an ongoing effort in basic research into advanced transportation concepts.

As a user, General Motors requires freight transportation to move a broad spectrum of materials and components into our manufacturing plants and to move a wide variety of finished products out of them. Freight transportation is a virtual extension of our production lines — on both ends.

The extent of GM operations means we deal in big numbers, and I do not mean to smother you with numbers. But it may serve as an indication of the scope of our transportation requirements to point out that last year in North America we moved some 80 billion pounds of freight and paid a freight bill of nearly $2 billion. As an indication of how that is split up by modes, somewhat more than half of our freight tonnage moves by rail, and trucks move almost all of the remainder. Air freight, although a critical component, accounts for less than 1 percent of the tonnage.

To facilitate the shipment of both product components and finished products, we monitor rail car movements by computer. For some shipments, we consolidate our routings so the railroads can group them into single trains, improving railcar utilization and bypassing rail yards to relieve congestion. We have freight consolidation centers. We interface rail and truckaway carriers at rail distribution ramps located throughout the country to speed the delivery of finished vehicles to dealers, and we schedule two-way loaded moves of truckaway carriers where we can. We use various means of packaging and protecting our vehicles in shipment, including closed-container railcars.

From this user/supplier perspective, then, what do we see as some of the critical issues for future freight systems? I will touch on three.

This is an appropriate time to consider these issues. I say that, partly with the National Transportation Policy Study in mind — but mostly in the political context of the times. I mean, of course, the transition to a new Administration. It's a couple of weeks before Electoral College votes will be cast in state capitals and more than a month before they will be counted in the U.S. Senate to make it official that Jimmy Carter is the nation's next President. But the decision has been made, and no matter how close it was or which candidate any of us may have favored personally, Mr. Carter has been elected President of all the people. So it is important for all of us to work together — to work with this new Administration as effectively as we can.

Listing his top priorities in a news conference — at the Plains railroad depot — the morning after the election, the President-elect did not mention energy. Neither candidate said much about it during the campaign. But energy is the first of the critical concerns I would emphasize. General Motors has called repeatedly for a comprehensive national energy policy, and while I will not elaborate here, I can provide statements of our position for any who might want them. General Motors hopes that once in office, Mr. Carter will make the adoption of a rational energy policy an early order of business. For the nation's vulnerability to another oil embargo increases, and an increase in the price of foreign oil appears imminent.

My point, of course, is that an energy policy must address the question of energy for transportation. Rational energy policy cannot be separated from national transportation policy.

Now, General Motors believes the nation <u>can</u> have plenty of energy for transportation in the future. We have said so in public forums on numerous occasions. But the operative word is <u>can</u> — not necessarily that we will. And we just may not, unless we do better than the patchwork and piecemeal policies put together so far — unless we come up with a sound policy that reserves each fuel for its most appropriate use. As the National Transportation Policy Study Commission work plan puts it, in something of an understatement: "Energy has had a dramatic impact on transportation in recent years, and it can be expected to play a critical role in the development of future transportation."

Without belaboring the significance of transportation beyond the functional aspects of the services it provides, I like the way Wilfred Owen put it a dozen years ago. "Transportation," wrote Owen in <u>Strategy for Mobility,</u> "is not a separate sector of the economy but instead is a necessary ingredient of every aspect; it is the web that joins all sectors together."

And today, of course, that web is spun from oil. Our nation's transportation system, for all intents and purposes, is entirely dependent on oil. According to the latest available data — and these are the government's numbers — our present dependency is 97 percent, with no really significant technological alternatives to oil in sight for the balance of this century.

Yes, the nation will be moving toward an electrical age as the fourth quarter of the century winds down, but oil nonetheless must have a first dedication to transportation during this period.

At General Motors, looking at the next couple of decades, we see mostly a continuation of present transportation trends rather than departure from present patterns. This applies to the movement of both people and goods. And it applies, in freight transportation, to the competition between railroads and trucks.

Some people have been saying how much more energy efficient it would be to ship everything by rail. But the fact is that's as impossible as doing entirely without railroads would be. The simple answer, as usual, proves to be a simplistic answer. Even if it were possible to move all motor carrier freight to rails, the savings in petroleum consumption would be slight.

As the nation's freight requirements increase with growth – and GM anticipates about a 50 percent rise in intercity ton/miles just within the next decade – we think all modes will participate in the increase. Freight transportation needs will be served by nothing less varied than the multimodal transportation system now in place. Now, one thing this suggests is that the maintenance and improvement of the highway network is no less important than the rehabilitation of neglected railroad rights-of-way. The price of deferred maintenance in the one case ought to be lesson enough instructing reasonable people to avoid repeating the problem in the other.

Having arrived at this juncture while inquiring into some energy aspects of our future freight systems, I want to turn now to another of the critical issues. That is the matter of capital formation.

As in the case of energy, the implications are by no means for transportation alone. Yet if we have an energy problem of major proportions, and we do, so too we have a serious capital formation problem. For those who like the word "crisis," it will do nicely in both instances. I suspect we have become so inured to that term that it is without impact, even when it is apt.

Call it what you will, the many tasks that confront us as a people, including improved freight transportation, impose capital requirements that are severely straining the private sector's traditional role of responding to them. In this connection, I would make just two observations. For one, I cannot say it any more simply or effectively than John de Butts did recently in Detroit – in eleven words: "To serve we must build, and to build we must earn."

But since capital formation involves borrowing as well as earning, my second observation is the reminder that almost four out of every five dollars available for capital needs of business and industry is being borrowed by government to finance its record deficits. One effect of such massive government use of these capital resources has been to limit the expansion of American industry.

Citing the need for a government role that encourages rather than inhibits private capital formation brings me to a third critical concern for the future of freight transportation – indeed, for the future of the nation itself. That is the whole question of the extent of government involvement – a question which must be answered in countless specific cases as well as in broad philosophic terms.

What is – and what should be – the role of government and the role of the private sector?

It is, of course, the question which nationalization poses, as one example. My friend, Charles Baker, picking his way through this tangled thicket, observed that a piece of the nation's railroad system – in his words – "is being operated under something this side of nationalization, but certainly the other side of private enterprise." There are those who would have the whole rail system go all the way over to the side of nationalization. Yet where does history or experience anywhere support the argument that nationalization is preferable to private enterprise? Where? Nowhere that I know of.

To cite another current and controversial example, the question of the respective roles of government and the private sector is posed by deregulation. Surely, from the viewpoint of the private sector, this would seem to be a good idea. And it is sound – in principle – but does that necessarily make it a good idea in all instances? Highway common carriers are answering "No." Free entry into any market may sound like a good idea, they say, until you consider that it also would permit free exit from any market, that without regulation some areas wouldn't have any trucking service.

I mention their position to make the general point that cannot really be disputed by reasonable people. Some regulation is necessary and reasonable in any organized society, and the need for regulation may be expected to increase with the complexity of society. Questions of how much regulation, and what kind, and at what cost – these kinds of questions need to be asked and answered, and reasonable people will differ on what the answers should be in particular cases.

What this implies, however, for the private sector is a relationship sometimes obscured by particular differences. Put in simplest terms, that is to say that business and government are not adversaries, they are partners. We are partners. And it is in that spirit, I suggest, that we need to address the problems we are going to have to solve in order to have the freight transportation systems we will require for the '80's and '90's.

I referred earlier to the timeliness of discussing these matters just now as we make the transition to a new Administration. I cannot speak for the entire private sector, of course, but I do come as a spokesman from one private enterprise company which is part of the very fabric of our nation's transportation systems. And I come, hoping – urging – that the government seek maximum communication with the private sector from the outset of this new Administration.

At the same time, those of us in the transportation industry, or using its services, need to put forth our very best efforts improving what we have, promoting the maximum efficiency of our current systems in all respects – including, or should I say especially, the structural organization of transportation modes and the interfaces between them.

Transportation is a total system for the movement of people and goods – you can't even really separate out freight systems as something distinct. Its elements have to be coordinated and integrated to provide a balanced system in which each mode performs the functions for which it is best suited. And the whole must function as one.

So how do we get there? I, for one, suggest we do it with less hand-wringing. We do it with less bemoaning about the plight of the railroads or the cutbacks in new highway construction or shortages of energy or any of the other problems, real as they are. What I urge is that all of us in transportation and interested in transportation lift our sights a little. That we take a look at the ever-increasing volumes of goods that will have to be collected, moved and distributed if this country is to have the continued growth we must have. And that we make up our minds that together we can and will do the job. So let's get on with it.

Dr. S.W. Herwald
Vice President, Strategic Resources
Westinghouse Electric Corporation

Dr. Herwald has held a number of key management positions within Westinghouse since joining that organization in 1939. Currently, as vice president of strategic resources, his responsibilities include the direction of the corporate strategic resources staff, corporate product integrity, and overseas licensing. Dr. Herwald is a recipient of the Westinghouse Order of Merit, the highest honor bestowed on employees for outstanding work. Elected a member of the National Academy of Engineering in 1967, Dr. Herwald is currently serving on the National Research Council-Assembly of Engineering committee on transportation and the BART impact program advisory committee.

CONFERENCE PAPER

"PRESENTATION OF THE WOODS HOLE MEETING OF THE COMMITTEE ON TRANSPORTATION OF THE NATIONAL ACADEMY OF SCIENCES – NATIONAL ASSEMBLY OF ENGINEERING – NATIONAL RESEARCH COUNCIL (JULY 1976)"

I am here representing the Committee on Transportation of the joint NRC activity of the Academies of Science and Engineering. What I am going to try to do is tell you about the planning and the status of the U.S. Freight System Study that we are currently performing for DOT, working hand in hand with the people here at the Transportation Systems Center. There are a number of members, and you may have seen them here, of this Study Committee . . . Al Boyd was here, Bill Spreitzer, Bill Harris, Sam Clausner, Rene Miller, John Fowler, and myself. That is really a pretty good representative group of the Committee, and I think almost any of them could tell you what I'm about to tell you.

However, before I start on those particulars of the study, I really can't resist making a few comments about what I thought I heard yesterday. Number one, TSC – and I think it is particularly appropriate to the members of our committee who have watched TSC from its foundation, floundering for a mission – has taken hold as a transportation system center. Today they really provided what, to me at least, is an excellent forum and a top-flight program to begin to grapple with a problem as tough as this one is. John Barnum, Ham Herman, and Jim Costantino, along with all their colleagues, certainly deserve congratulations for the efforts and the results in a field that obviously is so difficult.

Secondly, I heard absolutely nothing new yesterday relative to how freight could or should be handled better in the future. As a matter of fact, not all of what was said yesterday can be simultaneously true. And that is the basic subject that our committee has got to cope with: what is true and what is not true.

Third comment: I couldn't agree more with the various comments made yesterday about new technology per se not necessarily being the answer to the problem. That has almost been the watchword of our committee ever since we started to delve into the problem. They said, "You just can't isolate this problem as you can a military program and talk about solving it technically in your own backyard. On this one you have to interface with people and institutions." A lot of people who are advocates of technical solutions have been people who have done very well in bringing technical solutions to military problems. But, if you'll let me use another word, "innovation," and include under that umbrella technical innovation along with social, economic, and institutional innovation – either alone or in combination – then these innovative solutions should not be ruled out as possible contributors to improved freight handling.

I think if we start using the word, "innovation," we will keep technology in the right perspective. It is a way to innovate; it's not the only way to innovate; and it certainly can help some other innovations take place. Just at random, there is no question that computer technology is not new, but you can tell it is just being introduced, and gingerly at that, as an innovation to solve some of the freight transportation problems. The great innovation that brought us to our current state of moving freight on wheels was basically not technical, but rather an ingenious combination of making every driver of every vehicle that currently uses petroleum on any road pay for the future construction and maintenance of an interstate highway system that is constructed with sufficient strength to allow shared use of that system, as well as all the other roads, by the truck-trailer freight handling system, along with a never-ending debate of whether they're paying their fair share or not. But that certainly was an innovation and is probably the biggest one that you can talk about as to what has happened previously in freight-handling transportation.

And last but not least, the time constant for making major changes in infrastructure, particularly where existing infrastructure exists and has value, so that you just can't tear it down, is long. Anybody that kids themselves in thinking you are going to make a transition in a few years is making a mistake. If innovation is going to occur, at least in my mind, then innovation is going to be compatible with using the existing infrastructure better and gradually building a new infrastructure that works better. I don't think that was said quite so clearly yesterday.

Well, with that off my chest, I will now get down to the official business, and talk about what the Committee is doing. But I think that background fits the mood of the Committee, and maybe it was right to set the stage first before I talk about the Committee work plan. It does give me pleasure to talk to this group, because I have known a lot of you for a lot of different reasons at various times. It's a tough study we're trying to do, and we certainly need all the help we can get. It is not the simplest problem to grapple with. As a matter of fact, some people on the Committee thought we were crazy for tackling it, because it is nice to tackle studies that you can wrap up and say, "Here's a solution." I'm not sure that we ever will be able to say that on this one.

Let me talk just a little more about how we got where we are. In two of the Committee's previous studies, "Urban Transportation Research and Development" and "A Review of Short-Haul Passenger Transportation," we were concerned primarily with passenger travel. In that process, however, the common use of rights-of-way, airways, and airports frequently brought up issues involving freight systems. One of the basic issues is who's paying what share in every transportation system because the method of total funding is different in almost every case. With this considerable involvement of the Committee with this range of issues, the assistant secretary of transportation for systems development and technology, the Honorable Hamilton Herman, asked that the Committee undertake a central role in the design and assessment of a program of study on freight systems. This effort will be the major part of the work of the Committee on Transportation for the coming two years. That time span gives you an idea how tough everybody thinks this task is. Because of the enormous complexity and the maturity of the freight system and the subtle relationships (and some not so subtle as you heard yesterday) that occur between the various modes, some rather specific objectives are required as to how to assess reasonable alternatives for improvement. What I am going to tell you is just a gross description of the studies we think are needed, as identified during the Freight System Seminar conducted by the Committee at Woods Hole this past July, and refined in meetings since then.

We arrived at suggestions for the broad scope and initial outline of some of the individual pieces of information that must be assembled. One of the big problems is what is true versus what's not true; what's the real data say rather than conventional wisdom – and when you look for the real data it's pretty scarce compared to the opinions that are around. In addition, we have outlined the time scale in which the Committee intends to complete its job. The job includes advisory functions to the Department of Transportation, the acquisition of additional needed information that I've talked about, and other resource needs. I hope this very brief outline gives you a good idea of what we're trying to do on what we consider to be a nationally important subject.

Work is in progress on a number of improvements that should cause our existing freight system to do an incrementally better job of moving things from one point to another, but with emphasis on the very short term. And certainly these things should be done. If we are wasting, as was said yesterday, 60 percent of our effort on the fraction of the problem that we just talked about, we should be able to change that. These individual modal efforts are certainly needed and they are being made, but there is a pressing need for a multimodal look at our national freight system. Many questions are being asked that appear to go deeper than the surface-level questions regarding the technical horizons for the various modes, and the organizational or regulatory changes necessary to achieve a given improvement of efficiency or to accommodate advance systems. In short, the entire setting of the rail, barge, truck, air, and pipeline shipment of goods should be examined to more specifically set into context studies that deal with present problems and opportunities for the future and how we make the transition.

The freight transportation system of the United States, both domestic and international, supports a wide range of resources, producing, manufacturing, and assembly operations. There are indications that problems such as extensive railroad bankruptcy may well affect, in an undesirable manner, national and regional economic and social growth. Accordingly, it is the task of transportation research and analysis to anticipate where current trends are leading and what the most appropriate remedial actions might be. In this context, it's also necessary to consider the changing role of the freight transportation system, the trends of and the demands for current transportation services, as well as the innovative and technological horizons for the various modes. Furthermore, any additional role that freight transportation might play should be examined and the steps required to achieve such a role determined.

I might just insert one simple kind of problem that doesn't appear to have a solution. We have got the Conrail people wanting to abandon lines, which, they say, are lines that cost them maintenance money and don't really serve a purpose. And at cross-purposes, particularly in my state of Pennsylvania, we have the governor screaming to high heaven that you don't take an inch of track out. Now, someplace, somebody's got to be wrong.

We hope that a deeper understanding of the nature of these institutional obstacles that affect the transportation system can be assessed and appropriate action considered. For this purpose the Committee plans to do the following: (I will give you the simple titles, even though these tasks are not simple to do.)

1. Identify a set of questions that should be answered.

2. Outline activities that will provide more complete answers to those questions.

3. Provide objective balanced counsel and support services on selected DOT projects falling within this matrix of activities.

4. Through appropriate media, including reports, suggest priorities and issues to be emphasized in forthcoming programs of DOT.

The general program of studies will cover a number of such reports that focus on issues important to the future of freight movement over the next 20 years or so. Within the task described there is work under way now or planned for the future by DOT, and, in addition, the Committee will arrange for the results of studies and discussions from outside DOT to be made available to members. (And let me just say that we certainly encourage anybody here who thinks they have got any ideas either to contribute or questions to ask to please let John Fowler know. We're anxious to find anybody who thinks he has got an idea that might be worth pursuing in this area.)

The first general task is to determine what demands will be made on freight systems and given an extrapolation of current trends and considering future needs, what will be the critical problem areas in the next 10 to 20 years. Because we must be able to see out there, and because, I think it is fair to state, there won't be much total change in the existing infrastructure — there won't be many changes that are going to have any appreciable effect within that time span.

In addition to the DOT studies, there has been previous work done by the National Research Council's Transportation Research Board. And there is work at universities and industries that will have to be considered by this Committee.

The second task is to postulate and evaluate the different possible freight systems. We think one advantage in doing this is that we can postulate hybrid freight systems. I don't know what you feel you heard yesterday, but I feel we are pretty well constrained in thinking right now to each mode pretty much thinking they're going to do it all alone. It really doesn't happen that way, because the shipper doesn't let the transporter do it all alone. A portion of this task is presently planned with DOT involvement. The Committee will, however, obtain and consider results from other sources as well.

Third, realistic appraisal of the feasibility of achieving desired futures. In short, what is possible. One of the major technical contributions will be the DOT studies; but views based on foreign experience; on appraisals by labor, industry, and the legislative branches of government will be included for consideration by the Committee.

And fourth, review the public role relative to investment in freight modes. How are public/private investment decisions now made and where is public policy leading us to in the transportation field? What necessary changes in the government, private, and institutional structures are required to achieve the alternate futures that we define in the section I talked about above. In this respect, I think it is necessary to examine the key institutional obstacles to the introduction of innovation (new technology along with changes in institutional, economic, or any other structures). And, conversely, how new development would affect institutional changes — would they accelerate them, or would they harden them? This phase essentially defines what must be changed to do what is needed. And here the primary contribution is expected to be from outside DOT.

The Committee, finally, will recommend R&D projects on innovation, both hardware and institutional, that will aid in the accomplishment of the several steps that I just described. In making its report, the Committee will draw on DOT studies and reports, but will of course include consideration of reports and discussions from outside the department and outside the country, and assure the appropriate assessment of the interrelationship of the technical, the socioeconomic, and the institutional factors. A number of issues to be investigated, as well as the specific information that must be collected, have been assembled to serve as a rough guide in the performance of the actual study. They are certainly not meant to be all-inclusive and are not presented in any particular order of difficulty or importance. Furthermore, with the limited funds and the time available to the Committee it is possible that not all of the listed tasks or issues will fully receive needed attention. However, even a brief consideration of some of these areas may reveal projects that will be reported to DOT for future R&D activities.

At this stage in our planning, we have permitted a considerable amount of overlap to remain. But I think we can adjust to a suitable degree as we proceed. One general task is the outline of scenarios that will reveal the kind of institutional and technical innovations that will be either necessary or expected. A proposed TSC assessment of technology horizons will be helpful in this task. However, many of the technical innovations that are possible or potential in freight transportation are unlikely to be adopted because of institutional or regulatory (as a specific in that area) impediments. Some of the institutional changes in scenarios that are going to have to be explored are the following:

1. Making rail transport more manageable and cost effective by reducing the number of private railroad companies.

2. Putting the railroads on a financial basis comparable to other transport media by public-sector development of rights-of-way with leasing arrangements for private operating companies.

3. Modifying transport regulation to permit the creation of transportation companies that could operate a variety of carriers. (I plan to touch on this point in more detail later, but I might mention here that the way we started exploring this was by talking with the top officials of both Canadian National, a government-owned company, and Canadian Pacific, a private company; we also plan to explore other examples of this kind of future to get the views of the people who already are doing these kind of things.)

4. Study developing new public/private systems, including equipment manufacture and operating services for freight systems.

5. Expand federal responsibility from the present DOT program to a continuing program of federal aid for railroads comparable to promotional efforts for other transport fields.

6. Study of possible grant conditions that might be imposed on railroad management to hasten desirable operating changes.

7. Explore other institutional changes that might advance the possibilities of a systems approach to the planning, financing, development and operation of freight facilities and services.

I might say the Committee does not have the vaguest idea right now as to what percentage of what I have outlined we can really get done. We don't know where we might strike out or where we might hit gold, but we think it's important to look at these factors as deeply as we possibly can. Among the various areas to be investigated, a number of them relate to the general economic issues associated with freight movement. Here is a sample. (I think you heard a fair number of them yesterday.)

What is the economic environment in which the transport system of the U.S. is going to be functioning over the next decade or two? The transportation is related to GNP, so you can start with something as simple as, What's GNP going to look like over the period we're talking about? What are the railroad costs? I won't even go into that because the data, in my mind, need refining before you can meaningfully assess what the relative costs are. What determines intermodal substitution costs? Time, service characteristics of the air, road, water, and rail? How do the shippers really make the decisions? How will the rail freight system fit into our patterns of energy use, traffic congestion, and atmospheric pollution? What are the likely technological changes that will prove to be economically feasible in our freight transport system? How should the nation's economic priorities be changed, if at all, in favor of support of rail freight? How should the separate pieces of the freight study that are being pursued be fit together in order to provide a comprehensive, overall analysis of the freight system as a whole instead of just comparing the different modes.

This is just to give you a feel for the topics that should be considered and for which information is needed, and I hope you will excuse me for doing this because I'm expecting something in return. There are enough people in this room who know something about this subject; we expect at some time, if you've got some ideas, as I said, to contact John Fowler. So, the following are representative samples of what we think we need in the way of information: (i) the nature of the demand for transportation services; (ii) labor relations; (iii) regulatory matters, including economic, safety, and environmental aspects; (iv) financial matters; (v) the technology of transportation; (vi) operations; (vii) management structure; and (viii) certainly the compatibility with national economic objectives.

If we take into consideration those elements, it may be possible to identify many of the strengths and weaknesses of the various modes involved in goods movement that characterize the constraints on the transportation system that may be affected by changes in public policy, private and public management, and technology arising from R&D.

You may recall that early in this discussion I mentioned that, in addition to the DOT studies, the previous work done by the Academy's Transportation Research Board, by universities, foreign governments, and industry will be considered by this Committee. We have also discussed problems and issues with a number of the transportation suppliers. We've already talked with the Air Transportation Association, the American Trucking Association, and the Waterways Association. I also mentioned we were in Montreal talking to actual operators. We interacted with users (and a variety of users . . . General Mills, Westinghouse). We are working with others and getting their views on how they see the transportation system.

We also plan to discuss many of the institutional aspects of the freight system with labor representatives and the Departments of Commerce and Labor officials early in this coming year. In the fall of '77, we plan a report that will identify and define what we perceive are the critical problems in the goods movement system and will include suggestions concerning the potential for improved performance through application of existing technology. In the fall of '78 we plan a report for recommendations for specific long-range R&D programs that have high innovative possibilities that would have capability to overcome the critical problems identified in the first 1977 report.

As another action closely related to the freight system study, the Department of Transportation, the Committee, and the Transportation Center of Northwestern University will cooperate to conduct a workshop on motor carrier economic regulations that will be held at the National Academy of Sciences on April 7 to 8, 1977. I have mentioned in this discussion of the freight system study that the entire regulatory system is in need of reassessment. This motor carrier workshop is intended to contribute to that process. The workshop is planned as an open meeting, and public notification announcements are being sent out by the Academy, the Department of Transportation, and the Transportation Center of Northwestern University. Dr. Leon Moses, director of the Center, is assisting the Committee in planning for and conducting the workshop. We have published the request for research papers on the issues to be covered, and these are to be submitted no later than February 4, 1977. Papers will be selected for presentation by February 25, 1977. Proceedings of the workshop are to be published in the fall of 1977.

I hope that gives you a feel, and maybe not too much of a feel, of what it is we are trying to do. I have deliberately gone into some depth on the subject because it is complicated enough that I at least want to give you a feel that we do know it's complicated and difficult.

DISCUSSION PANEL

"FUTURE TECHNOLOGICAL DEVELOPMENTS IN FREIGHT TRANSPORTATION"

Remarks by
John F. Lynch
Vice President
Bechtel Corporation

Based on Paper by
E.J. Wasp, Executive Engineer
and
R.H. Derammeleare
Slurry Systems Engineer
Bechtel Corporation

International Steam Coal: The New Energy Competitor

The Energy Crisis

The recent turmoil in the world petroleum picture has raised the price of crude oil to $11/bbl from $3.50/bbl for major industrial consumers such as Europe, Japan, and the United States. This tripling of crude prices over a short span of a few months has, of course, left competitive forms of energy with little opportunity to react. The general reaction has been one of passive criticism and, at best, an establishment of procedures to make do with reduced supplies.

The purpose of this paper is to explore the competitive positions of known steam coal deposits near tidewater, hence world markets. Projected are international movements of steam coal by ocean to the industrial nations from areas such as Alaska, Colombia, Australia, etc. Also presented are alternate modes of overland transportation (rail and slurry pipelines) from mine to coast and coast to consumer to close the total transport concept picture and provide a delivered cost of steam coal.

Not included in this paper will be any discussion of internal movements of coal from the western United States of Wyoming and Montana to the Midwest markets.

Economic Incentive

A barrel of crude oil at $11 converts to an energy equivalent of $2 per $\overline{M}$Btu (million British Thermal Units). Traditionally, the price relation between coal and crude oil is that coal has been valued at 80 percent of the price of crude. Therefore, if we take $1.60 per $\overline{M}$Btu with present day crude oil prices, we have unleashed a new concept in world trade. This concept is that steam coal deliveries from overseas can become a major source of energy for the industrial nations of the world.

World Movements

The simplified world map of Exhibit I shows known coal deposits near tidewater with hypothetical ocean routes to major industrial centers and the convergence of flow patterns to Japan as a suitable consumer of coal from deposits in Alaska, British Columbia, Australia, Borneo, and China.

The presently existing steam coal embargo by Japan will, of course, be presumed to be lifted in view of the need of alternate energy supplies. To selected areas of the United States, we can visualize imports from the South American continent. Colombia, Chile, and Brazil have considerable deposits near the coast from where northerly sea routes can establish markets with California or Florida, and conceivably with the European continent. Finally, large deposits exist in the Transvaal, Republic of South Africa, and shipments to the United Kingdom are conceivable.

The movements traced are, again, hypothetical and, in addition, the traced routes are simplified: actual shipping paths will probably show multiple off-loading ports, and no doubt a different return voyage with a different cargo.

The impact of the map is that there are coal deposits close to tidewater to form logical trade patterns, and it is likely that some of these movements will someday materialize.

Total Transport: Concepts and Economics

Transportation Concepts

Several combinations are possible to transport coal from the mine to the overseas industrial centers. A few practical schemes are presented in Exhibit II to illustrate some concepts and derive economics.

In Schemes I and II, the mine sites are identical. The mine site is followed by the coal preparation plant where the coal is broken, washed, and finally ground to a top size of about 14 mesh. This product, in slurry form, is then pumped to the coast. A single pump station could suffice for distances up to 75 miles or more, but this, of course, depends on the terrain profile and other factors.

Mr. Lynch joined Bechtel's Pipeline Division in 1951 after four years of planning and designing pipelines for major oil companies. In his long career with Bechtel he has served as engineer, manager, and corporate executive, responsible for a wide range of activities.

The two schemes take different configuration at the coast. Scheme I provides a mooring buoy for offshore loading by pipeline into specifically designed vessels for slurry transportation. The Marcona Corporation is presently operating 50,000 dwt oil/slurry carriers for the transportation of iron ore slurries. The slurry is pumped into the bulkheads and water is allowed to overflow and drain, while solids settle to a compact sediment. The Marconaflo system is then used to reslurry the cargo for discharge at its destination. Centrifugal slurry pumps aboard ship will function as charge pumps for the first onshore mainline pump station. Finally at the power station, the slurry is processed through the dewatering plant and dryer to provide a product suitable for boiler feed.

The only slurry carriers in operation handle iron ore slurries. Fortunately, this product lends itself satisfactorily to gravity draining of the liquid phase, thus leaving in the bulkheads a firm mass of solids.

Coal slurries, however, do not exhibit likewise draining characteristics. Transportation of the slurry without adequate removal of the water may endanger the ship's stability by shifting off gravity center and remaining dislocated. An interesting article has been published which discusses dangers of concentrates transportation in cargo vessels, relative to such factors as moisture content or degree of saturation. On the other hand, shipping excess water will impair the transportation economics. Therefore, Scheme I can only be considered to be hypothetical pending further research and technology advances in this field.

In the case of Scheme II, the pipeline product is dewatered at the coast and loaded aboard ship in the form of a filter cake, thus requiring conventional port facilities. The vessels here will be of different construction, with a configuration now designed to accept bulk or ore cargos. On the industrial continent, the cake is reslurried and transported by pipeline to the dewatering and thermal drying plant ahead of the power station. In the Scheme III arrangement, the coal is broken and washed only. The railroad is used exclusively for overland transportation. Again, port and handling facilities will be required to load and offload the coal. The grinding plant is situated at the power station.

Economics of the various schemes are discussed in the following section; however, the choice of the transportation method is primarily dictated by practical considerations. The coal deposits could well be too remote from harbors with adequate loading equipment. Alternately, the not too distant ports may not be suitable to accept large-capacity vessels. Such situations strongly favor the offshore mooring buoy loading concept. There are, of course, numerous other factors which will influence the selection of the type of transportation on land. For example, the topography may not be suitable for the railroad.

Delivered Coal Costs

It is not the intent of this article to predict specific delivered coal prices or to foresee that specific markets for steam coal between two points on the globe will economically be feasible. Today's markets are far too volatile for this, and today's costs do not escalate at a predicted rate, but move to ever-astounding levels. As one published article states: "This cost may be out of date before the ink is dry." The intent is to analyze the situation today, in general terms, and to demonstrate that, with the present economy, steam coal can be competitive on the overseas market with rendered oil. Therefore, this is sufficient an incentive to take a closer look at this alternative. This analysis does not take into account the overseas government tax position on the exported coal.

First we will consider the average distances of the hypothetical situations shown in Exhibit III. Commencing with the cost of coal at the source, a wide range must be taken into consideration to account for the type of mining, for example, deep, auger, or strip, and to cover the natural variations of international cost structures. It is assumed for the purpose of this presentation that the steam coal is strip-mined and is sub-bituminous with an average calorific value of 10,000 Btu/lb and 20 percent equilibrium moisture.

Therefore, if the mined coal, including breaking and washing, is available at a cost of about U.S. $4 per short ton, the equivalent energy rate is 20 U.S. cents per MBtu, as shown in Exhibit IV. (Use about 2 1/2 times this cost for deep-mined coal.) In order to project future trends of the total transport economics, for comparative purposes of the alternate schemes, some escalation rates will be provided. Again, these figures are only derivatives from historical data and must be viewed in today's perspective of spiraling prices. For strip-mined coal, escalation rates might be 5 percent, whereas for deep-mining as high as 8 percent.

In order to better understand the implementation of the escalation rates for the various transportation facilities, let us illustrate the methodology of calculating the effective overall escalation rate. The relative effect of escalation rates annually compounded is shown in Exhibit V. In other words, if it costs $1 to transport a ton of coal from South America to the European Continent, and the escalation is estimated at 3.5 percent, 20 years hence the tariff would be $2. The relative factor of escalation, therefore, was 2. In our examples we have assumed that the capital involved will be amortized over 20 years. The method of calculating the overall escalation rate is based on the use of the relative factor for 20 years, applied to each cost component. For instance, the slurry pipeline, as shown in Exhibit VI, is capital intensive which explains the modest escalation rates. Seventy pecent of the tariff is capital related; thus, once the investment is made, the charges are fixed. The remaining 30 percent is operating cost, which is estimated to escalate at 3 percent. Applying the relative factors for fixed and variable costs as illustrated in Exhibit VI, we now find a relative factor for the total tariff of 1.51, which averages 2.1 percent escalation on a 20-year basis. On a similar basis we find 1.7 percent for ocean freight and 6 percent per year escalation for railroad transportation.

In the next step, we consider the two alternatives: transportation by slurry pipeline or by railroad to tidewater. In the case of the slurry pipeline, the sensitiveness of tariff to annual throughputs and length of line is demonstrated in Exhibit VII (adapted from Wasp et al., "Economics of Slurry Pipeline Systems." The effect of pipeline length on unit cost is particularly evident with coal slurries because the slurry preparation as well as dewatering plants are included in the tariff, and fixed, irrespective of line length. For the average hypothetical distances, pipeline transport costs are estimated to be from 1.1 to 1.7 cents per ton-mile. This includes operating costs as well as capital amortization of preparation plant, pipeline and drying. Converted costs in cents per MBtu are shown in Exhibit IV. The railroad transportation costs for the short distances envisaged are of the same order of magnitude at 1.7 to 1.8 cents per ton-mile assuming that railroad facilities are not existing already. The rates expressed in cents per $\overline{M}$Btu have been calculated for the same distances as the pipeline, whereas it generally turns out that travel between two points yields longer distances for the railroad than the pipeline, due to the gradient restriction. The railroad is more labor intensive and therefore exposed to inflation to a higher degree. An escalation rate of 6 percent is assumed to be applied against rail transportation tariffs. The breakdown in fixed and variable components is shown in Exhibit VI.

Finally, ocean freight charges will be analyzed to complete the total transport cost picture. In Scheme I, Marconaflo vessels would be required to transport slurry cargos. However, the advantages of eliminating conventional loading facilities are balanced by higher ship capital costs and fuel consumption rates. Of course, it is assumed that the harbor and adequate crane or belt-type loading facilities are available, otherwise there is a definite incentive for the Marconaflo. Thus, shipping costs per ton of cargo will be, for all practical purposes, the same in each scheme. Using the Bechtel computer program for owned ocean vessel costs, a rate of $4.23 per long ton was established for the hypothetical voyage of 4,200 nautical miles on a coal cargo, returning on ballast. In Scheme III, it is assumed that the coal slurry is transported at its settled concentration, or about 60 percent by weight. The excess water thus transported is reflected by higher energy equivalent rates, that is, 27 cents per $\overline{M}$Btu as compared to 20 cents per $\overline{M}$Btu for Scheme III to transport "as received" coal (that is, 20 percent inherent moisture and 5 percent surface moisture). Likewise, Scheme II is penalized for the transportation of excess water in the form of $\pm$18 percent surface moisture on the filter cake, with a rate of 23 cents per $\overline{M}$Btu. The various components which constitute the calculated ocean freight rates have been analyzed and weight-averaged for escalation, yielding 1.7 percent.

Finally, we can establish total delivered estimated costs for strip-mined steam coal. As shown in Exhibit IV, these figures vary little from one scheme to another, that is, 63 to 70 cents per $\overline{M}$Btu, but the escalation rate, on the other hand, is appreciably higher in the case of railroad transportation, that is, 4.8 percent for Scheme III whereas only 2.6 percent for Schemes I and II. Exhibit VIII clearly illustrates the effect of the higher exposure to inflation. For further illustration, the cost curve for deep-mined coal, using the Scheme II transportation alternative, is also shown.

Focus on Colombia

The above transportation costs were calculated for the average distances of hypothetical movements shown in Exhibit III. These unit costs can now be related to the export of steam coal from Colombia. Exhibit IX is a map showing coal deposits of Colombia. In the north, from the Cerrejon area, we could establish a market across the Caribbean Sea, say with Florida. A pipeline could be installed from Cerrejon to the coast, approximately 150 miles, with dewatering facilities at Santa Marta. Tariffs are shown in Exhibit X. The transportation cost of the coal to the harbor would be of the order of 6 cents per $\overline{M}$Btu. The round-trip sea voyage from Santa Marta to Florida is approximately 3,000 miles, and shipping costs would be 13 cents per $\overline{M}$Btu on a 250,000 dwt bulk carrier for a cargo of coal filter cake. The coal can be off-loaded, again by conventional means, on the North American continent. The cake is reslurried, pipelined to the power station, where it is dewatered and thermally dried for a total cost of 11 cents per $\overline{M}$Btu, yielding a grand total transportation cost from mine to consumer of 30 cents per MBtu, and with 20 cents per $\overline{M}$Btu mine cost, coal could be delivered for 50 cents per $\overline{M}$Btu. Another hypothetical case is to transport coal from the region of Carca via the port of Pizarro to Los Angeles. The ocean trip is somewhat longer, but still, the total transportation cost is only 37 cents per $\overline{M}$Btu. In other words, assuming that the coal is mined for 20 cents per $\overline{M}$Btu, its delivered cost would still be less than 60 cents per $\overline{M}$Btu.

As previously mentioned, sea transportation is achieved by 250,000 dwt vessels. The effect of vessel size on shipping costs is worthwhile mentioning. For example, if 50,000 dwt were to be used instead, the transportation costs from Cerrejon to a power plant in Florida would increase from 30 cents to 47 cents per MBtu. Large vessels are therefore significant for these movements.

The Coal Slurry Pipeline: Future Energy Mover

Technology

Technology for slurry pipelines is well established. The Black Mesa coal slurry line and earlier the Consolidated coal slurry line have operated successfully. Proven design procedures exist on the basis of laboratory bench-scale tests without the need of costly and sometimes misleading hydraulic loop tests. These laboratory tests coupled with computer-model projections allow accurate prediction of such design criteria.

Coal Pipelines

For the past three years, the Black Mesa pipeline has been moving millions of tons of coal across the state of Arizona. It supplies the energy to the Mohave power plant near Bullhead City, in the Mohave Desert. About 275 miles to the east lies the Black Mesa coal mine. Over 5 million tons per year move into the power plant via the 18-inch diameter pipeline. Three intermediate pumping stations are located at about 80-mile intervals. The power plant is located on the Colorado River because of the large amount of cooling water required for thermal power generation. The coal pipeline, incidentally, provides about 15 percent of the plant makeup water requirements.

Economics of Slurry Pipelines

The economic incentive in selecting the slurry pipeline as a mode of ore transportation has been often proven and is now common knowledge. Here are some of the factors which affect the cost of slurry pipeline transportation. The cost is a function of the tonnage transported, distance, physical characteristics of the solids, conditions of terrain, and the annual capital charges of the pipeline. The two most significant factors are the annual tonnage and the distance transported. Exhibit XI clearly shows the effect of these variables, as well as comparative costs of railroad transportation. The costs, expressed in cents per ton-mile, may be considered as typical for a coal slurry pipeline, and include operating costs as well as capital charges for the slurry preparation, pipeline transportation, dewatering, and thermal drying.

Unit trains represent the major long-distance transportation alternative to coal slurry pipelines when the energy is transported in the form of coal, except for these instances when existing waterways are available for barge transport. Where new transportation facilities must be installed, a new pipeline is nearly always more economical than a railroad. However, railroads may be quite competitive where existing trackage can be employed to a large extent, but even in this case, the use of existing facilities may be offset because rail distances are usually greater than the pipeline distance between source and delivery point. Furthermore, rail economics may also be offset by higher escalation rates attached to railway cost components.

While economic factors are the primary ones dictating the selection of the method of transportation, such choices may also be influenced by secondary factors. Some of the factors favoring slurry pipelines are as follows:

High Operating Factor

Slurry pipelines, like pipelines for the transportation of crude oil or natural gas, have a high degree of reliability and are therefore capable of high operating factors. The Consolidation Coal Company pipeline, for example, had an operating factor of 98 percent. The gilsonite line in Utah has a similarly high operating factor. The Black Mesa pipeline system has experienced availabilities of over 99 percent.

Immunity to Escalation

Slurry pipelines are relatively immune to the effect of escalation. Approximately 70 percent of the unit cost of transportation is made up of capital-related fixed costs. Nearly half of the remainder is accounted for in fuel costs, and 85 percent of the annual transportation costs may be considered as virtually immune to the effects of escalation. Exhibit XI illustrates the effect of escalation for railroad and pipelines.

Economy of Scale

Slurry pipelines offer the tremendous advantage of scale. Unit costs of transportation decrease dramatically with increases in annual volume.

Fewer Personnel

Slurry pipelines are less sensitive to labor disputes. Modern, highly-automated pipelines require relatively few operating and maintenance personnel.

Esthetics

Slurry pipelines have an esthetic advantage over other modes of transportation — as nearly all facilities are buried and out of sight.

In conclusion, we believe that slurry pipelines offer a new dimension of major importance to the selection of systems for the transportation of solids.

Conclusion

Let us return to our basic theme which was that if overseas steam coal can be marketed at or below $1.60 per $\overline{\text{M}}$Btu in the industrial nations, a new concept in world trade will be unleashed. We analyzed an average situation and projected a delivered coal price of 63 cents per $\overline{\text{M}}$Btu for Scheme II, Exhibit IV. We then turned to a rather favorable case with Colombian coal delivered on the Northern Continent for 50 cents per $\overline{\text{M}}$Btu (Exhibit X). But now let us even consider a more unfavorable extreme, say deep-mined coal from the region of Newcastle in South Africa: 180 miles to tidewater, 6,200 nautical miles to the United Kingdom and finally 200 miles from port of entry to the consumer, and still only for little over $1 per $\overline{\text{M}}$Btu (Exhibit XII). These figures are conclusive: not only do we find that for hypothetical movements of up to 6,500 miles, steam coal can compete, but being one-third to one-half of present day crude oil prices could become an important stabilizing force in the volatile world energy market. Lastly, delivered costs will not be subject to severe cost escalation.

* * * * *

Question: In an isolated comparison, pipelines may have many advantages – including cost – over railroads. But might not substantial investment in coal slurry pipelines be the straw that breaks the railroads' back, permanently? Is it worth it if this is the likely outcome?

Answer: The characteristics of coal slurry pipelines are such that they can best serve in moving a portion of the western coal reserves to distant consuming centers. Unlike many of their counterparts in the East, the western railroads are in quite good financial shape. Western coal movements, now in the order of 60 million tons annually, are expected to grow fivefold and more over the next 10 to 20 years. The assumption that coal slurry pipelines will "break the railroads' back" is specious because we are talking about western coal movements in which new business will be created. Western railroads must gear themselves to handle several hundred million tons of new business over the coming years. Pipelines are only a part of this new business. What pipelines will do, however, is to prevent the western railroads from charging a monopoly price for their services. It really comes down to the question of whether in an economic environment such as we have in this country, this society still believes in the open competitive process as the means of achieving real benefits to the ultimate consumer.

Question: How does coal transport compare in costs to transmission costs of DC high voltage power from power plant at or near coal supply? Which way saves most fuel?

Answer: Coal slurry pipelines are far more efficient and economical than DC high voltage transmission.

Question: What about water availability? How much of the available water in that Wyoming County would be needed? What would be the cost increase if you were required to compensate water users?

Answer: There is plenty of water available in the West. According to the Wyoming State Treasurer, "an annual average of some 17,340,000 acre feet of water are generated and flow within the state of Wyoming." Water for the ETSI pipeline will come from 3000-foot wells drilled into the Madison Formation, a massive aquifer underlying northeastern Wyoming. The Madison Formation is estimated to contain as much as one billion acre feet of water and the recharge from rain and snow is estimated to be 100,000 acre feet per year. Of this one billion acre feet, an average of 15,000 acre feet per year will be required to move 25 million tons per year of coal. Water availability is largely a question of utilization and also the price a particular user can pay for the water. In the case of the ETSI pipeline, all costs for developing the water are borne by ETSI with no subsidy from any state or federal agency and the underlying landowner will be compensated for access to his land.

Question: How does the quality of the water separated from the slurry at the end of the coal slurry pipeline compare with the process water field in at the source? Is it acceptable to EPA requirements for discharge? What percentage of the total transportation cost is consumed by the solid/liquid separation process at the end of the line? What is done with the water at the end of the line? Where discharged?

Answer: The water quality at the discharge end of the pipeline is the same as at the entrance of the pipeline. Therefore, if the water meets EPA requirements going in, it will meet it going out. In a long-distance, 1000-mile pipeline approximately 10 percent of the cost is associated with the solid-liquid separation at the end of the line. The water is used beneficially in the cooling tower circuit and it is not generally proposed to discharge it in a public stream.

Question: How important an issue is the use of water in coal slurry? Considering the low supply of water in the West, does this divert substantial amounts of water from irrigation and drinking resources?

Answer: As noted in the answer to an earlier question, water availability is adequate in the West provided one is willing to pay the cost of developing the water from sources not accessible to irrigators. For example, irrigators traditionally pay anywhere from $10 to $20 per acre foot of water. The ETSI pipeline water delivered to the surface from deep wells would, in an irrigation context, cost $400 an acre foot. Even at this level of cost, the cost per ton of coal for water used would be about 30 cents, or roughly 3 percent of a $10 per ton delivery cost. With regard to the supply of water, the main stem Missouri dams could supply, according to federal authorities, up to 3 million acre feet of water per year. Even if all of the coal projected out of the Powder River Basin in 1985 (250 million tons per year) were pipelined out, the total water requirement would only be 150,000 acre feet per year, or about 5 percent of the 3 million acre feet which the federal authorities estimate to be available. Water is, however, an emotional issue and our opponents, the railroads, have successfully exploited this issue to their advantage.

Question: Do you have a long-term contract to provide service to a certain shipper or shippers or do you provide service on a common carrier basis to shippers who need it? If so, what is the length of the contract?

Answer: Long-term contracts are required to finance the pipeline. The pipeline will be regulated under the ICC as a common carrier. The length of the contract will vary with the individual commitment and would range from 15 to 30 years.

EXHIBIT I

WORLD MAP
COAL DEPOSITS NEAR TIDE WATER AND PROJECTED MOVEMENTS

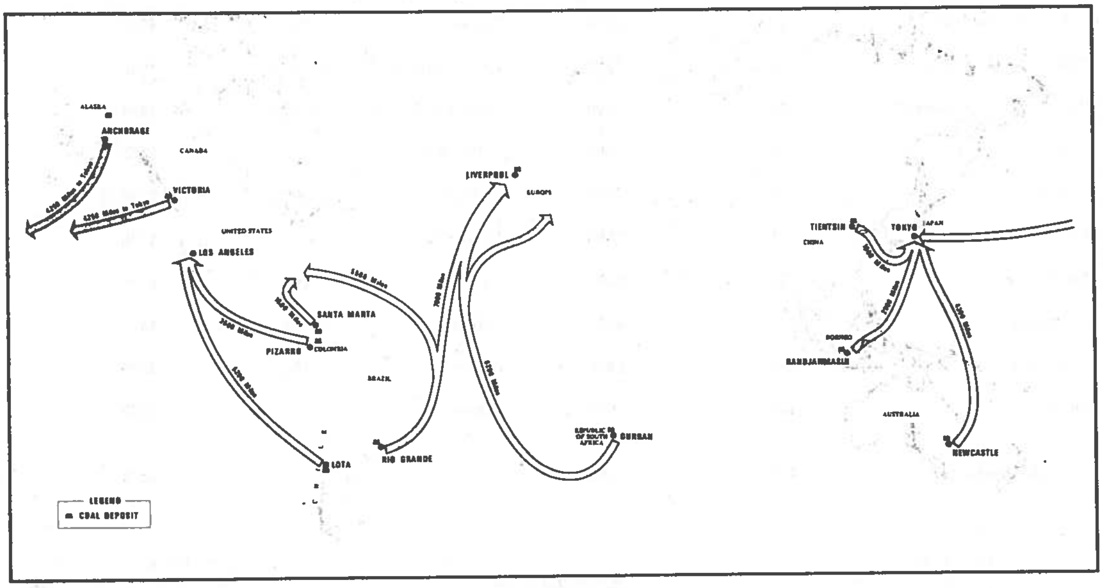


EXHIBIT II

CONCEPTS FOR OVERSEAS TRANSPORTATION OF STEAM COAL

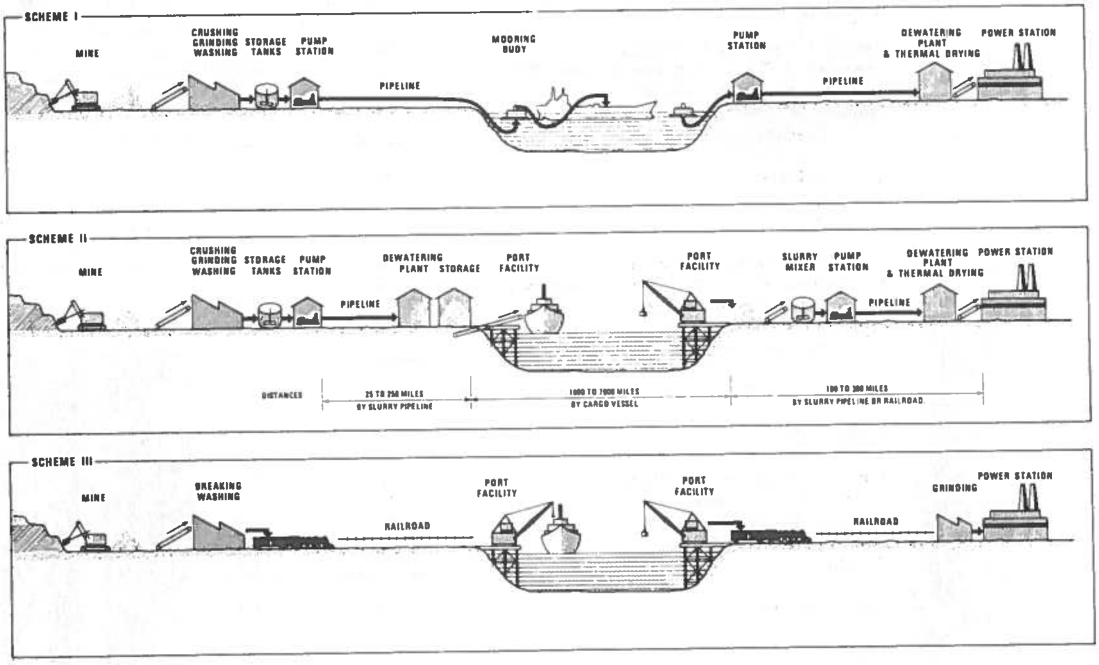


EXHIBIT III

DISTANCES OF HYPOTHETICAL GLOBAL STEAM COAL MOVEMENTS

Source of Export	Transportation to Tide Water (Miles)	Overseas Shipping (Nautical Miles)	Industrial Center	Overland Transportation (Miles)	Total Distance from Source to Consumer
Alaska	250	4250	Japan	200	4700
British Columbia	80	4250	Japan	200	4530
Colombia (Pacific)	150	3500	USA (West)	200	3850
Colombia (Caribbean)	150	1500	USA (East)	200	1850
Chile	30	5200	USA (West)	200	5430
Brazil	80	7000	Europe	200	7280
Brazil	80	5500	USA (East)	200	5780
South Africa	180	6200	Europe	200	6580
Australia	150	4300	Japan	200	4650
Indonesia	180	2900	Japan	200	3280
China	100	1800	Japan	200	2100
Average distances:	130	4200		200	4530

EXHIBIT IV

ESTIMATED COST OF DELIVERED STEAM COAL FOR AVERAGE TRANSPORT DISTANCES

Distance to Tide Water : 130 miles
Ocean Voyage : 4200 nautical miles
Harbor to Consumer : 200 miles

	Cost in US ¢/MBtu	Possible Escalation Rate (%)
SCHEME I		
Mining + Breaking & Washing	20	5
Preparation Plant + Pipeline to Tidewater	7	1.1
Shipping by Slurry Carrier	27	1.7
Pipeline to Power Station + Dewatering & Thermal Drying	11	1.1
Total Delivered	65	2.6
SCHEME II		
Minng + Breaking & Washing	20	5
Preparation Plant + Pipeline + Dewatering	9	1.1
Shipping by Ore/Bulk Carrier	23	1.7
Pipeline to Power Station + Dewatering & Thermal Drying	11	1.1
Total Delivered	63	2.6
SCHEME III		
Mining + Breaking & Washing	20	5
Railroad to Tidewater	11	6
Shipping by Ore/Bulk Carrier	20	1.7
Railroad to Power Station	17	6
Grinding	2	1.1
Total Delivered	70	4.8

Notes:
1. Costs are based on average distances shown in Exhibit III.
2. Annual transportation assumed to be 5 million tons.
3. Average coal value estimated at 10,000 Btu/lb, 20% equilibrium moisture.
4. For deep mining use approximately 2-1/2 times cost of strip mining.

EXHIBIT V

RELATIVE EFFECT OF ESCALATION

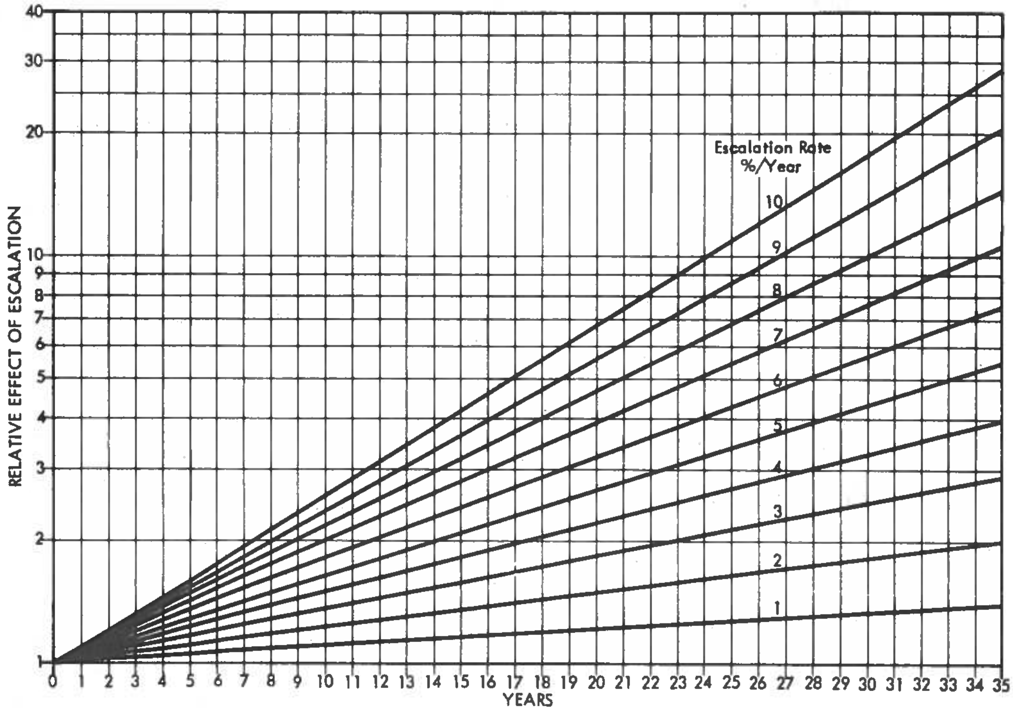


EXHIBIT VI

ESCALATION EXAMPLE

20-YEAR PERIOD

	COSTS		
PIPELINE	Fixed	Variable	Total
Proportion	70%	30%	100%
Escalation Rate	0%	3%	
Relative Factor	1.0	1.76	
Proportion X Factor	70	53	123
Overall Factor			1.23
Overall Escalation			1.1%
VESSEL			
Portion	53%	47%	100%
Escalation Rate	0%	3%	
Relative Factor	1.0	1.84	
Proportion X Factor	53	87	140
Overall Factor			1.4
Overall Escalation			1.7%
RAILROAD			
Portion	20%	80%	100%
Escalation Rate	0%	7%	
Relative Factor	1	3.80	
Proportion X Factor	20	304	324
Overall Factor			3.24
Overall Escalation			6%

EXHIBIT VII

SLURRY PIPELINE
TRANSPORTATION COST
COAL

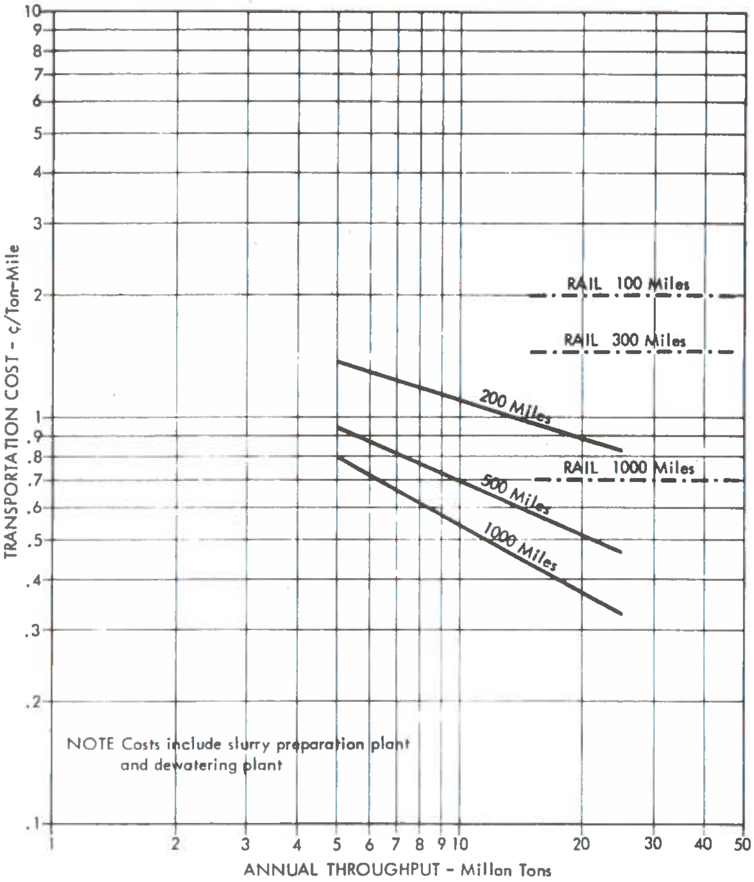
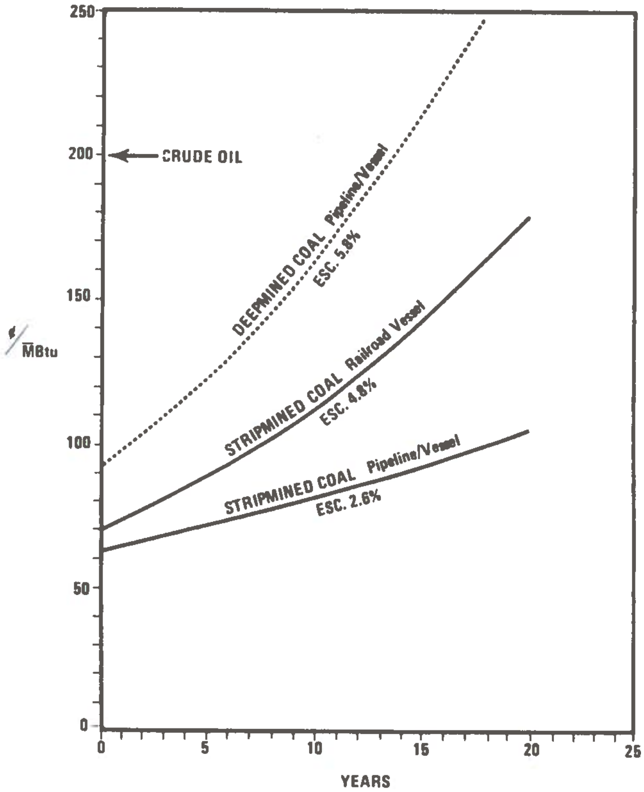


EXHIBIT VIII

ESCALATION OF STEAM COAL DELIVERED COSTS



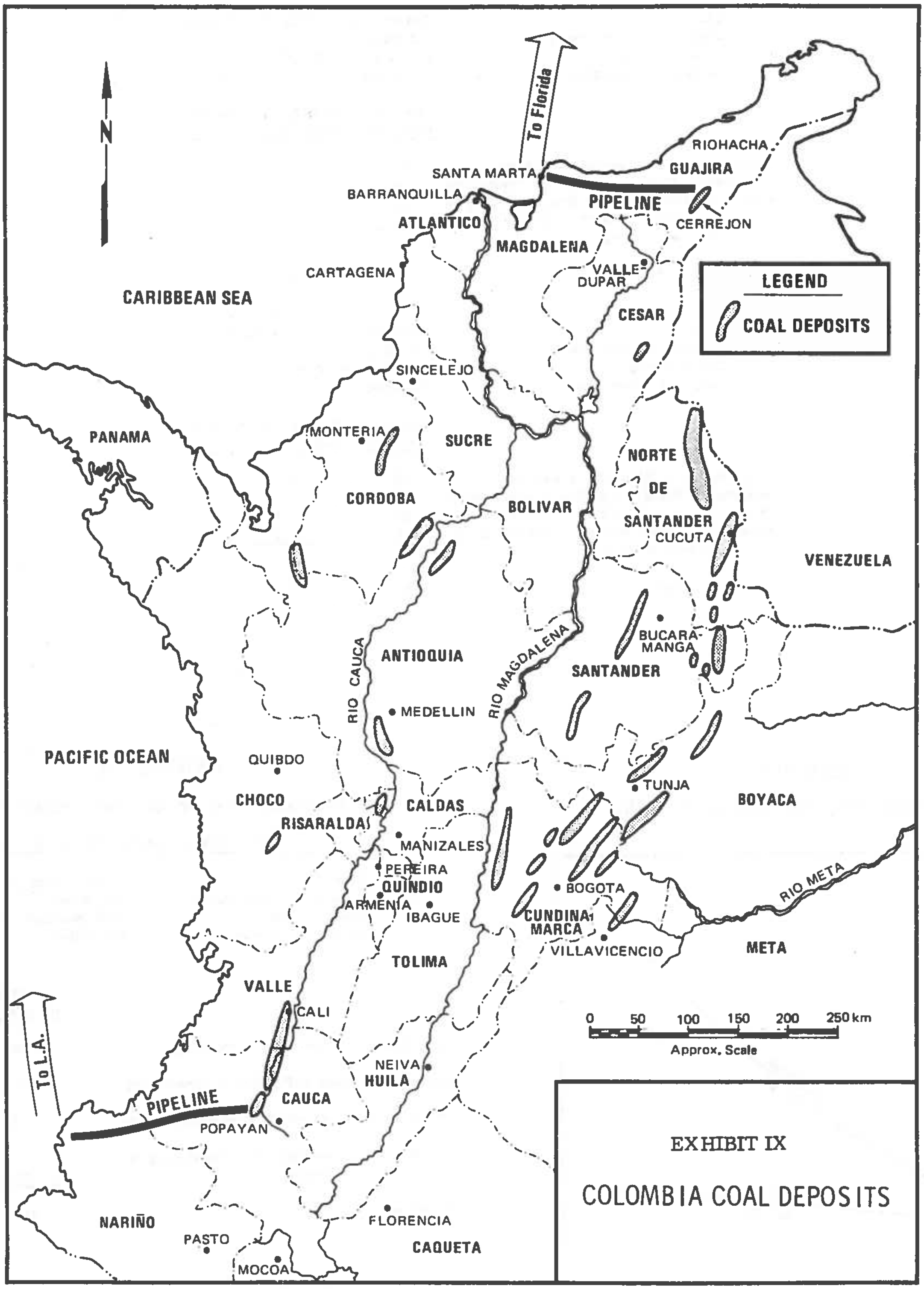


EXHIBIT IX

COLOMBIA COAL DEPOSITS

EXHIBIT X

ESTIMATED COST OF DELIVERED STEAM COAL

EXPORTED FROM COLOMBIA

Case	:	Colombia to Florida (Caribbean)
Distance to Tide Water	:	150 Miles
Ocean Voyage	:	1500 Nautical Miles
Harbor to Consumer	:	200 Miles

	Cost in US¢/M̄Btu	Possible Escalation Rate (%)
Strip Mining + Breaking & Washing	20	5
Preparation Plant + Pipeline + Dewatering	6	1.1
Shipping Filter Cake by Ore/Bulk Carrier	13	1.7
Pipeline to Power Station + Dewatering & Thermal Drying	11	1.1
Total Delivered	50	3.1

Case	:	Colombia to Calif. (Pacific)
Distance to Tide Water	:	150 Miles
Ocean Voyage	:	3500 Nautical Miles
Harbor to Consumer	:	200 Miles

	Cost in US¢/M̄Btu	Possible Escalation Rate (%)
Strip Mining + Breaking & Washing	20	5
Preparation Plant + Pipeline + Dewatering	6	1.1
Shipping Filter Cake by Ore/Bulk Carrier	20	1.7
Pipeline to Power Station + Dewatering & Thermal Drying	11	1.1
Total Delivered	57	3.0

EXHIBIT XI

INFLATION: RAILROAD VERSUS PIPELINE

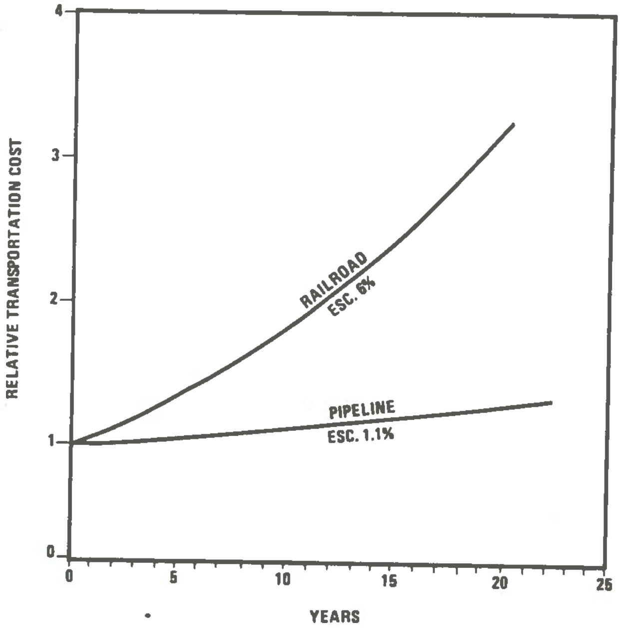


EXHIBIT XII

ESTIMATED COST OF DELIVERED STEAM COAL

FOR UNFAVORABLE EXTREME

Case	:	South Africa to Europe
Distance to Tide Water	:	180 Miles
Ocean Voyage	:	6200 Nautical Miles
Harbor to Consumer	:	200 Miles

	Cost in US ¢/M̄Btu	Possible Escalation Rate (%)
Deep Mining + Breaking & Washing	50	8
Preparation Plant + Pipeline + Dewatering	11	1.1
Shipping Filter Cake by Ore/Bulk Carrier	30	1.7
Pipeline to Power Station + Dewatering & Thermal Drying	11	1.1
Total Delivered	102	5.6

DISCUSSION PANEL

"FUTURE TECHNOLOGICAL DEVELOPMENTS IN FREIGHT TRANSPORTATION"

Remarks by
Phillip L. Peoples
Director of Logistics Transport Development
Boeing Commercial Airplane Company

Based on a Paper by
M. Lynn Olason
Director – Air Freight Systems
and
A. Dean Reynolds
Air Freight Systems Economic Analysis
Boeing Commercial Airplane Company

Introduction

The purpose of this paper is to provide a view of air freight developments over the next decade.

Before we try to do that, it might be very useful to look back over the last 10 or 15 years to see where we are and to develop some understanding of how we got into the position that we find ourselves in today. Therefore, we are going to go back over the last 15 years and review the economic situation and assess the impact of selected air freighters in an attempt to develop some guidance in forecasting what we might look forward to in the next 10 years.

Firstly, as shown in Figure 1, we have displayed the reported average total operating cost of the all-cargo operations of U.S. airlines starting back in 1962 and up to the end of 1975. These data were extracted from Trends in Air Cargo Service, 5th Edition, December 1975, published by the U.S. Civil Aeronautics Board, and are directly applicable only to the U.S. airlines. However, we believe that the cost trends shown are generally representative of the major airlines of the world because the economic fundamentals are similar worldwide.

This is a strange-shaped curve starting very high, around 30 cents per revenue ton-mile in 1962, and dropping to approximately 16 cents per revenue ton-mile (almost one-half) in 1966. From 1966 through 1971 we see a gradual increase, followed by a reduction from 1971 through 1973; and finally, from 1973 through 1975, we see a dramatic increase in cost.

In Figure 2, we have superimposed the average revenue yield for the same period. Revenue was approximately 22 cents per revenue ton-mile in 1962 and declined less rapidly than costs to about 17.5 cents in 1968. From 1968 through 1973 there was a gradual rise, and the most recent two years have been characterized by a rapid increase that has not kept up with the upward surge in operating costs resulting from the abrupt worldwide increase in fuel prices.

The industry, as a whole, has operated at a loss except for the brief period between 1965 and 1969. This picture is not quite as bleak as indicated here because it is mitigated to some extent by the effects of depreciation. The industry, in the aggregate, has consistently achieved a modest cash operating profit but, nonetheless, it is plain that the incentive to make large investments to develop the freight business is minimal.

The Period 1963-1973

Let us get back to the cost chart, analyze the situation, and try to explain the various changes. Considering only the portion of Figure 1 that deals with the years 1962 through 1966 (Figure 3), we see a sudden reduction in costs from about 30 cents per revenue ton-mile to about 16 cents. Also shown are the estimated total operating costs for the DC-7F, 707, and DC-8. You will note that the total operating costs of the 707/DC-8 jet freighters were in the neighborhood of 12 cents when they were introduced, in contrast to the 30-cent level, which was representative of the propeller-driven airplanes in the fleet in that time period.

The principal reason for the observed improvement in operating economics was the great productivity of the jet freighters. A 707-320C will carry about three times the payload of the DC-7F and will fly about twice as many miles per year, thus representing a sixfold increase in productivity. The key factor is that this very large increase in productivity was not accompanied by a proportionate increase in direct operating cost. As a matter of fact, some of our data indicate that the maintenance cost of a 707, per flight-hour, was not much different than that of a DC-7. If that situation were entirely accurate, the maintenance cost per revenue ton-mile alone would be reduced by a factor of six because of the increase in productivity.

As the jet freighters displaced propeller airplanes, their relatively lower operating costs influenced the average costs very dramatically during this period. Figure 4 shows the phase-out of the piston-engine airplanes and the introduction of the jet airplanes – the 707, DC-8, and the 727 – which came into service as cargo carriers. Looking back again to Figure 3, you can see that the total operating costs curve is reasonably well explained by the fleet composition wherein the system was dominated by piston-engine airplanes during the early part of the period, while the fleet was dominated by the jet airplanes during the latter part of this period.

In addition to the changes in the fleet mix there was also a concurrent revolution in freight handling with bulk loading of airplanes giving way to prepalletized freight, which currently dominates the market. This change undoubtedly affected the indirect operating costs, which also showed a downtrend.

Now, let's move on to the period from 1966 to 1970, Figure 5. Here you'll find the increases in costs for both the 707 and DC-8 that are considered to be due to inflation. The slope of the dotted curve, representing the 707 and DC-8, shows an increase in operating costs of about 5 percent annually. Also shown is the 727 estimated total operating costs, also with a 5 percent yearly increase. There is remarkably good correlation between the reported fleet average total operating cost data and the 727, 707, and DC-8 estimated costs, with a yearly escalation of 5 percent.

In Figure 6 we have expanded the cost chart to include the years through 1973. The average total operating cost curve, which gradually rose due to inflation, leveled off and declined slightly during these three years. We believe that this trend was the result of two factors: the introduction of the more economical DC-8-63F, which has been added to the chart, and a sustained increase in load factor for the entire industry.

The DC-8-63F represents a substantial improvement over the economics of the basic 707 and DC-8 freighters. This improvement results primarily from the increased volume available in the stretched version of the DC-8 as shown in Figure 7.

In addition, the DC-8-63F made a significant penetration into the cargo carrier market as shown in Figure 8, where it provided 35 percent of the total revenue ton-miles by the end of 1973.

The other force at work was load factor, which had bottomed out in 1969 at about 50 percent, then increased steadily to about 57 percent by 1973 as market growth outpaced the addition of new capacity to the fleet and the last of the propeller-driven freighters were retired.

Fuel Crisis (1973-1975)

Figure 9 extends our picture to the years 1974 and 1975, and we see the very abrupt increase in operating costs that was brought about by the surge of inflation that accompanied the increase in fuel prices and the operational measures that were taken to conserve fuel during those years. We have shown the estimate of the operating cost trends for each of the individual airplane models so far considered. We have also added the 747F, which entered U.S. fleet service in 1974. The rate of operating cost escalation in these two years was more like 15 percent per year rather than 5 percent, which was considered more representative in earlier years.

In summary, then, this is how we can explain, with some degree of validity, the strange shape of the fleet total operating cost curve as discussed earlier.

A previous review of the profit and loss history revealed that the industry had been profitable for only four years out of the last 15. As pointed out earlier, this is not a very comfortable situation that would attract a large amount of capital to the development of air freight. The one ray of hope, however, is that the 747F does offer operating costs that are substantially lower than the other models. The fleet of 747's is still very small so that the fleet average operating cost is still dominated by the 707's and DC-8's, which carry 90 percent of the revenue ton-miles in U.S. industry today.

Based on this history and a cautiously optimistic view of the future world economy, our forecasters have developed the freight forecast contained in Figure 10, which also shows the estimated relationship between the freight carried by all-cargo carriers and freight transported in the lower decks of passenger airplanes. It is currently estimated that slightly more than one-half of the revenue ton-miles in the world market are carried in the belly compartments of passenger airplanes. It is expected, however, that by 1985 this split will have changed so that all-cargo airplanes will generate more than one-half of the total revenue ton-miles. The overall growth is projected at 11 percent per year in this forecast, which appears reasonable in light of history. Those of us who are in the business of developing air freighters would like to see a more aggressive growth pattern, and the remainder of this paper is devoted to a discussion of some actions that could be taken to make a more substantial growth occur in the all-cargo segment of the market. We will assume that the belly-cargo segment will continue in its present form – mainly small shipments in LD3 (or similar) containers.

The Period 1976-1985

Looking to the future, Figure 11 shows a continued development of the total operating cost chart starting from 1976. We have assumed that the large increases in fuel prices are behind us, and that the future will be characterized by the 5 percent annual escalation in costs similar to that experienced during the period prior to 1973. We have projected the 1975 level of operating costs for each of our airplane models at this rate.

You will notice that the 747 curve is labeled "random loads." By this we mean that the main deck of the 747 is loaded with a mixture of unit load devices (ULD's), some of which are igloos or pallets that were shaped to fit in the cargo compartments of the older freighters and thus do not utilize the volume of the 747 efficiently, as illustrated in Figure 12. The floor space may be full, but the total volume of the airplane is only partly filled. The capability of the airplane is such that it shows an operating cost advantage over the narrow-body freighters even in this configuration.

The diversity of the air-freight business is sufficient to permit carriers with quite different philosophies to be successful. There are currently two general schools of thought concerning how the market can best be serviced. One approach is based on the development of a system that will pick up, consolidate, line haul, deconsolidate, deliver, and account for small-package shipments. Thus, several hundred shipments may be included in a single airplane load. The other approach is to develop an intermodal air/highway system tailored to the transportation of large, prepacked, sealed containers in order to minimize pickup, delivery, and handling requirements. An airplane load would thereby involve relatively few, but large, shipments.

We consider the Flying Tiger Line to be representative of the first approach and Seaboard World Airlines to be representative of the latter approach.

Flying Tigers recognized very quickly the need to improve the volume utilization of the 747 and developed a pallet configuration that can be stacked as high as 118 inches, thereby taking advantage of the overhead volume (Figures 13 and 14). The rear cargo door on the 747F is 10 feet high and permits straight-in loading of these pallets. The problems normally associated with stacking freight to such a height have been avoided through the use of a midpallet shelf. The use of these units improves the volume utilization by 37 percent from the assumed random loading used in Figure 12, with a corresponding increase in available payload.

Intermodal Air Freight System Concept

Obtaining full utilization of the airplane volume is a commendable objective, but we believe that an additional step involving intermodality with the ground transportation system is necessary if the full potential of the air freight system is to be realized. Intermodality is not a new idea, having been practiced successfully in the surface transportation industry for a number of years, but its application in the air freight industry is in its infancy. We believe that the development of an air freight system based on this concept is important to the long-range factors of the industry because it will provide the option of servicing the larger shippers in a new way. The intermodal system concept is illustrated in Figure 15, and we can visualize a smoothly operating system built along these lines that could provide dock-to-dock delivery of intermodal containers anywhere in the world in a matter of two to three days. Moreover, we think most of the technology needed to synthesize such a system is available, since much can be borrowed from the surface transportation industry. The following paragraphs discuss the status of some of the critical elements of such a system.

The 747 freighter is the first commercial airplane with sufficient capacity to economically carry 8-foot-square containers similar to those used extensively in the surface transportation system. The volume of the airplane is not quite as efficiently utilized as it is with the special units described previously. Figure 16 is a sketch showing the payload compartment of a 747 loaded mostly with 8- by 8- by 20-foot units. We believe that, in the long term, the ability of these units to make an easy transition to highway transport will tend to offset the small volume loss.

The key element in an intermodal air freight system is the container. Figure 17 is a photograph of several containers that are currently used by Seaboard World Airlines in intermodal operations. These units are shown in the cargo compartment of a 747F after having been loaded using the powered roller floor system of the airplane. The principal problems in developing containers of this type for air transportation are to obtain sufficiently lightweight units that are rugged, relatively maintenance-free, and reasonably priced. The current stock of containers appears to be a good initial effort, but we believe that emphasis should be placed on the development of improved containers having less tare weight, since a weight reduction here is equivalent to a reduction in the operating empty weight of the airplane and an increase in revenue payload.

In addition to the 8- by 8- by 20-foot container, Seaboard World Airlines has been developing the other parts of the system. A principal element of the system is a mobile loader, which transfers containers from the airplane to a modified International Standards Organization (ISO) trailer chassis for over-the-road transportation. The loader has a roller-bed platform that is elevated to the level of the 747 cargo deck for loading and offloading and can be lowered to truck-bed height so that containers can be transferred to and from the trailer chassis, which have special nylon-surfaced bolsters. Figure 18 shows the loader in position to load the 747.

Figure 19 shows a container being transferred from the loader to a trailer chassis for highway transportation.

While Seaboard World Airlines is currently in operation with their roller-bed system, there are other intermodal options being developed. The surface transportation industry has for some time been using a technique that eliminates some of the disadvantages of the roller-bed system. Figure 20 is a photograph of three maritime-style air freight containers constructed by various manufacturers, all of which have corner fittings suitable for use with existing maritime container handling equipment. These containers are lockable and weatherproof. They are reasonably lightweight (2200 to 2400 pounds) — only about half the weight of equivalent maritime units. Their principal advantages are that they are compatible with the airplane roller system and all of the maritime handling equipment that is well distributed around the world.

Figure 21 shows one of the units on a standard ISO trailer, which uses a twist lock restraint system and can be towed by a commonly available truck tractor.

To further illustrate the intermodality of the units, Figure 22 is a photograph of one being lifted by a top lift unit at the Port of Seattle.

It is our opinion that the long-range future of air freight will be much enhanced with this type of container because of its commonality and compatibility with the equipment already developed for surface transportation.

Figure 23 shows in bar chart form our current estimate of the comparison of operating costs for the various system options that we have discussed so far. It should be emphasized that these are our current best estimates, and that cost studies are in progress to better understand these relationships.

The left-hand bar illustrates the total operating costs for the 707 and DC-8-50 airplanes and the second bar shows the costs for the DC-8-63F. These airplanes currently dominate the economics of the freight fleet. The third bar is our estimate of the operating costs of the 747 airplanes in the fleet, but operating with the kind of random mixture of unit load devices that we postulated earlier. Even with this relatively inefficient utilization of the airplane volume, the 747 offers improved economics over those of the standard body jets.

The fourth bar is an estimate of the results of using ULD's tailored to the 747 cross section such as the units that Flying Tigers have developed. As you can see, there is a definite advantage to be gained in this way.

The last bar illustrates our estimate of the operating cost of an intermodal system that hauls large prepacked containers primarily. This level of total operating cost is probably representative of the ultimate that can be achieved with the 747 as it currently exists, but it could be a significant factor in offsetting the cost escalation that appears to be inherent in the economy.

In Figure 24, we have returned to the chart of total operating cost in order to show the effects of the two new factors introduced in the discussion, that is, filling up the airplane and intermodal operations. Again, a 5 percent annual escalation has been applied to the 1975 values shown in Figure 23.

At this stage in the discussion it may seem that the estimated reduction in operating costs is not completely fair because in the last case we have merely shifted some of the handling costs from the airlines to someone else. Regardless of how the costs are allocated, if the consolidation of goods can be directly into an intermodal container and the loadings and unloadings of vans and pallets can be avoided, these kinds of savings should result. Accordingly, we are postulating a substantially different technique than that which exists today. It seems to us that the growth in the air freight business must come from its eventual appeal to the larger shipper rather than depending on the continued transport of small packages.

There is no rigorous way of predicting the length of time required to convert the world-wide main deck air freight system to intermodal operations, but the surface freight industry may serve as an example. Figure 25 is a history of the number of containers used in the surface freight industry.

The acceptance of containerization appears to have been slow initially, but 20 years after the initial order, there are about 1.6 million 20-foot equivalent units in use, and the number is growing rapidly. With this background, the advantages of containerization should be well understood by the shipping community, and it seems reasonable to assume that a large share of the freight carried on the main decks of air freighters could be containerized in a decade. A few thousands of 20-foot containers will be required by the air freight industry as contrasted with the millions in use on the surface, but the impact on fleet average operating costs could be a downtrend as depicted in Figure 26. This favorable trend assumes that an efficient ground system will evolve to complement the 747 and the intermodal containers. It is largely up to the industry whether or not the total operating cost can be influenced as shown on this chart. To achieve the results shown, the standard body jets would have to be gradually phased out of the prime markets and be replaced by larger airplanes capable of carrying large loads in an efficient manner. This trend in operating costs is possible by this improved productivity even though the general 5 percent annual escalation is expected to continue.

747 Growth

If we assume that the air freight development as discussed so far is plausible, it would be reasonable to expect that there would eventually be a need for a new, more capable airplane on the prime routes in the world air freight system. There is a considerable range of possibilities for improving the capabilities of the 747 as the requirements of the market develop. The simplest change is a body stretch of up to 50 feet, which could increase the available containerized volume by approximately 40 percent. Figure 27 shows a comparison of the main deck configuration of the standard airplane with that of a stretched one. The stretched airplane would, of course, have additional lower deck capacity for LD3 containers or other suitable units.

Another option would be to enlarge the cross section of the 747 body to provide space for 8- by 8-foot containers on the lower deck. This option could be exercised if the demand for transportation of this type of container warrants the change.

Figure 28 illustrates the body cross section that would result from this change in comparison to the standard body. The ultimate way of increasing the capacity of the airplane would be to both stretch it and enlarge the cross section, which would result in an overall containerized volume increase of approximately 65 percent over that of the standard airplane.

Changing the payload capacity of the airplane by 49 percent to 65 percent would require changes in other airplane characteristics in order to preserve an acceptable level of performance. Preliminary design studies have indicated that the gross takeoff weight of the airplane could grow to about one million pounds. To accommodate this weight, it would be necessary to provide increased wing area, which could be accomplished with a center section insert or a new wing. It would also be necessary to provide additional engine thrust; it presently appears that growth versions of current engines will provide adequate thrust levels by the time they are needed. Figure 29 is a photograph comparing a display model of the standard 747-200F with a model of the growth version of the 747 just described.

In summary, we believe that advanced versions of the 747 can meet the requirement for additional capacity and lower operating costs for the next 10 years through capacity increases added to the existing airplane as summarized in Figures 27 through 29. The result could be a continued tendency for the average total operating cost to resist the advances of inflation as shown in Figure 30.

Up to this point, our discussion has centered primarily on the effects of the 747 freighters, but we fully recognize that there will be requirements for other freighters. We believe that, as in the past, the smaller freighters of the future will be derived from passenger airplanes, and these airplanes of the 1980's are now being examined on the preliminary designers' drawing boards. At Boeing, for example, a number of studies are under way. Some of these are entirely new airplanes such as the 7X7, while others are based on derivatives of existing airplanes such as the 707. The effect of ignoring other potential freighters does not significantly alter the basic theme of this paper, so no further consideration is given to their influence.

Dedicated Freighter

You are probably wondering why there has been no discussion of freighters designed entirely for cargo service (dedicated freighters). Our fundamental reasoning is that the commercial freight market may not reach a level that would justify the investment necessary to design and develop an entirely new freighter during the time period we are considering – the next 10 years. Look at it this way: Comparisons have been made that show that the revenue ton-miles in the total air freight market will some day soon equal the revenue ton-miles of passengers carried. However, considering that a given airplane is about three times more productive as a freighter in terms of pounds of payload carried than it is in passenger service, the revenue ton-miles in the freight market must exceed those in the passenger market by a factor of about three in order to require an equivalent number of airplanes. This is an oversimplified way of looking at the problem, but it illustrates why dedicated freighters are not rolling off the production lines today. This statement should not be taken to mean that we at Boeing are not examining dedicated freighters, because we are. A considerable number of talented preliminary designers are working in this area constantly, and we are watching the market develop. If the market responds by growing rapidly, our assessment of the future could change; we are preparing ourselves for that eventuality.

The incentive for a new freighter could come from the military arena. We find a degree of consistency when we compare the requirements for military freighters with our concept of a dedicated commercial freighter (provided we limit our consideration to strategic military airlift rather than tactical). It is conceivable that the melding of these requirements could result in an airplane design that is viable in both markets.

Figure 31 illustrates our current concept of a large, long-range freighter that could serve both the military and commercial needs of the future.

This airplane has the capacity to carry 30 equivalent 8- by 8- by 20-foot ULD's arranged in four parallel lanes, which could be simultaneously loaded or offloaded through a large nose door. In addition to its capacity for carrying standard load units, this cargo deck configuration could be very versatile for the transportation of oversize units, which will not fit in conventional airplanes. Items having widths up to 16 feet and heights to 12 feet could be loaded in the portion of the cargo deck forward of the wing, and units to 10 feet high can be carried anywhere in the airplane. This capacity would enable the airplane to carry virtually all of the military equipment as well as a large share of the heavy equipment in the commercial market.

Figure 32 shows the cross section of this advanced freighter with some typical commercial and military payload options. The body shell of the airplane is configured in a double-lobe arrangement to fit the wide floor required into a shape that can be readily pressurized. (Our studies have concluded that the freight market is so diversified that pressurization is a must.) Within this cross section, payloads as diversified as autos stacked two high, 10-foot-high ULD's, military trucks, heavy construction equipment, and even the U.S. Army M-60 tank, could be carried. Moreover, a considerable number of passenger seats for the transportation of military personnel, along with their equipment, could be provided.

In addition to the expanded payload (360,000-pound) capability of this advanced airplane, the effects of foreseeable technological advances have been incorporated such as advanced engines designed for improved fuel consumption and reduced noise. Refined wing design and advanced flight control systems for reduced cruise drag as well as advanced structural concepts and materials for reduced weight have all been incorporated into the design of this airplane. The result is a further improvement in performance and another reduction in total operating cost. The estimated results of all of these innovations are shown in Figure 33. Indications are that airplanes of this general type could help to continue the nearly level trend in fleet average operating cost in the more distant future notwithstanding a sustained 5 percent inflation.

At this stage it should be noted that we have woven into our cost estimates some trends that our market studies tell us may result from the evolution of the system. Better matching of airplane volumes with freight density should result in better load factors, although unbalanced flows in the system tend to limit the load factor that can be achieved. The average range of the airplanes tends to increase because of improved performance and our estimate of the distance that future commodities will move. Indirect costs tend to be reduced because of the projected effects of increased shipment size and reduced handling. All of these effects are included in the final cost curve.

Conclusions

In all the discussion to this point we have been emphasizing costs while deferring consideration of future revenue yields. Historically, yields have fluctuated as costs have fluctuated; generally following, with some lag, the cost pattern. In the face of rising prices in all other areas, wouldn't it be great if air freight rates could simply level off and remain constant? We have postulated such a situation in Figure 34 for purposes of discussion, with the full understanding that freight rates are not any of our business. Relating the postulated future revenue yield with the previously developed cost story provides a very encouraging profit situation that seems to be too good to be true. The air freight industry surely is entitled to earn a respectable profit; and with deliberate planning and product improvements, as we have discussed, it could happen. Obviously there are external pressures too numerous to consider in this paper that will alter this pattern. Nonetheless, if the industry develops a smooth-running, efficient, convenient, and reliable system, it will inherently be in the best posture to achieve a profitable position. It is incumbent upon the airframe manufacturers to continue product improvements and also for the airlines to develop the necessary operational innovations in a timely manner. Many airlines have already stepped out to do just that. Finally, if this rosy picture sustains itself through our mutual efforts, we might indeed earn the right to have a growth pattern in air freight, as portrayed in Figure 10 – a tripling of air freight revenue ton-miles in the next 10 years.

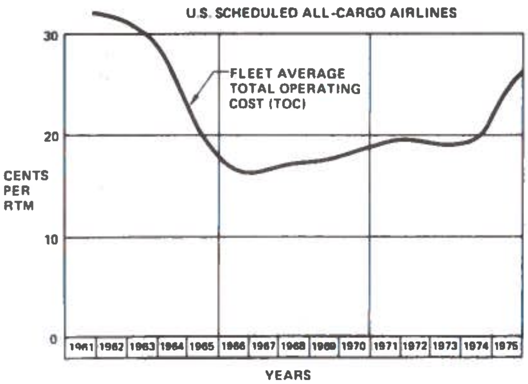
* * * * *

Question: What were your assumptions on future energy costs? What are your best estimates?

Answer: We escalated air freight operating costs at 5 percent per year on out to 1990. In the case of jet fuel, this corresponds to escalating from today's base of $.41/gallon at 5 percent which results in about $.80/gallon in 1990.

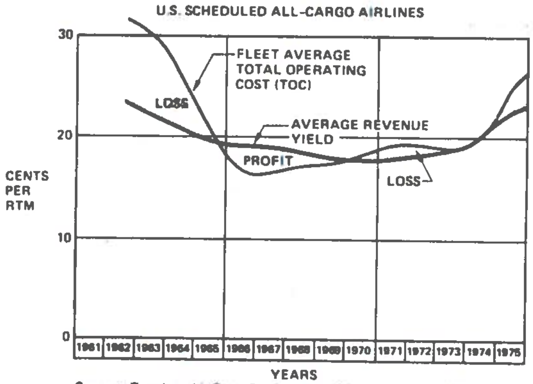
Question: Do you see in future all-cargo aircraft development, the possibility of a truck-bed height loading/offloading capability being built into the aircraft to avoid expensive and extensive support ground loading equipment?

Answer: It is conceivable that future commercial all-cargo aircraft could be built to truck-bed height without a large penalty to airplane performance and economics. However, it is not likely that a truck would interface directly with the airplane. Rather, that the airplane would interface with loading and unloading systems designed to minimize airplane turn-around time and ground crew labor. The current trend for commercial cargo loading systems is to standardize at the 12- to 16-foot deck height of the growing fleet of wide body airplanes. By the time a future freighter comes on the scene, we expect that this 16-foot loading system will be very extensive throughout the world and that the future freighter must adapt to it. As an example, by the end of next year, there will be about sixty 747's with main deck freight carrying capability flying into about 42 major cities of the world. Because of this well-established trend, it is doubtful that a future commercial freighter would be designed to truck-bed height unless there were very definite performance and economic advantages that we do not foresee today.



Source: *Trends in Air Cargo Service*, 5th Edition, December 1975

Figure 1 HISTORY OF U.S. SCHEDULED AIR FREIGHT INDUSTRY AVERAGE OPERATING COSTS



Source: *Trends in Air Cargo Service*, 5th Edition, December 1975

Figure 2 U.S. SCHEDULED AIR FREIGHT INDUSTRY AVERAGE OPERATING COST AND REVENUE YIELD

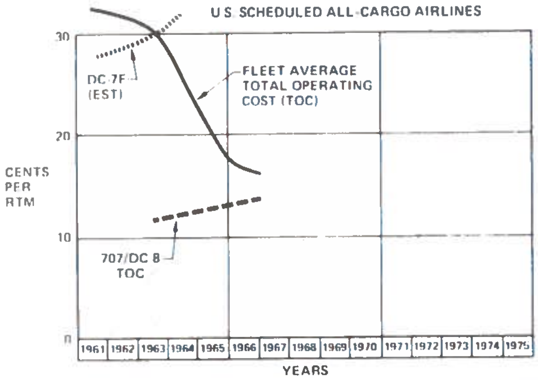
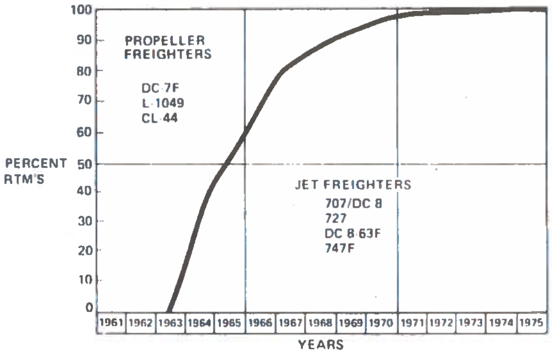


Figure 3 707/DC-8 FREIGHTER INFLUENCE ON FLEET AVERAGE OPERATING COSTS



Source: *Trends in Air Cargo Service*, 5th Edition, December 1975

Figure 4 JET FREIGHTER PENETRATION

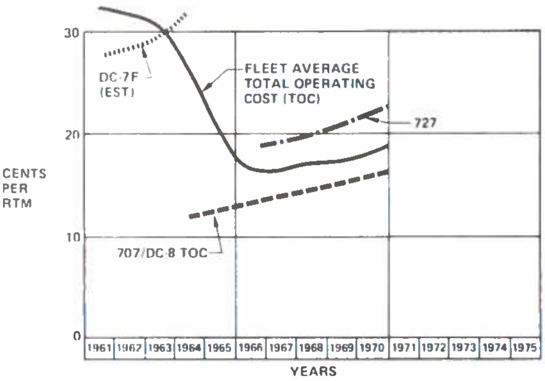


Figure 5 OPERATING COST HISTORY, WITH DC-8/707 AIRCRAFT DOMINATING THE FLEET

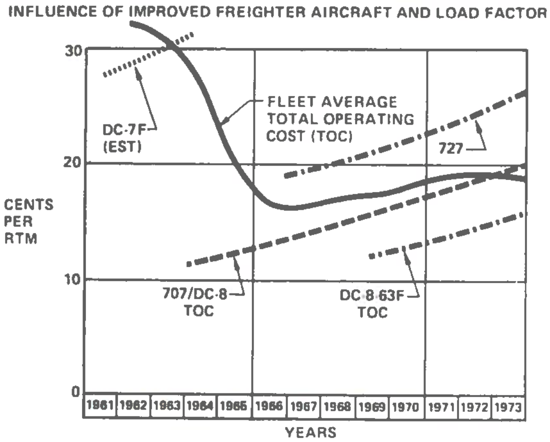


Figure 6 INFLUENCE OF IMPROVED FREIGHTER AIRCRAFT AND LOAD FACTOR

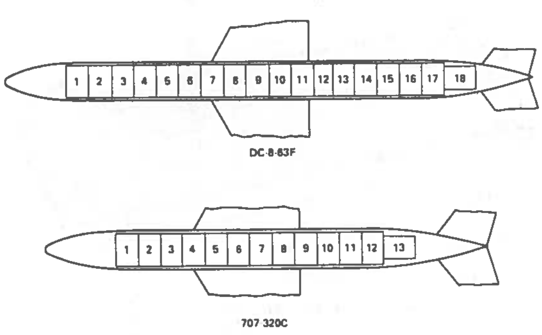


Figure 7 PAYLOAD CONFIGURATION COMPARISON

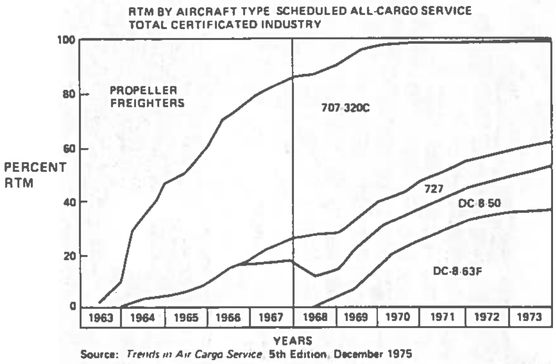


Figure 8 DC-8-63F PENETRATION

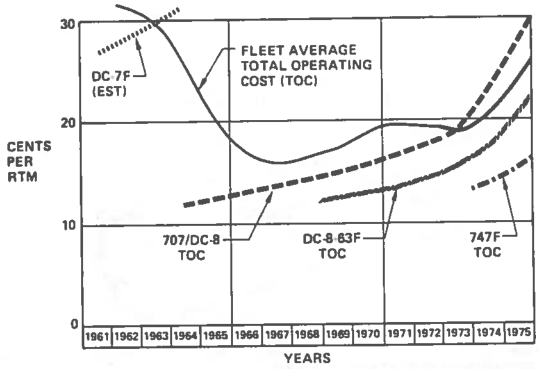


Figure 9 IMPACT OF FUEL PRICE INCREASES

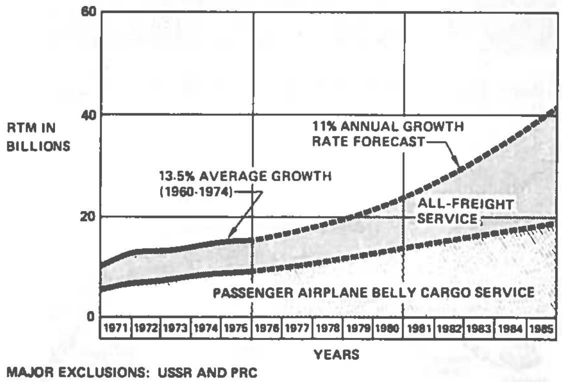


Figure 10 WORLD AIR CARGO FORECAST

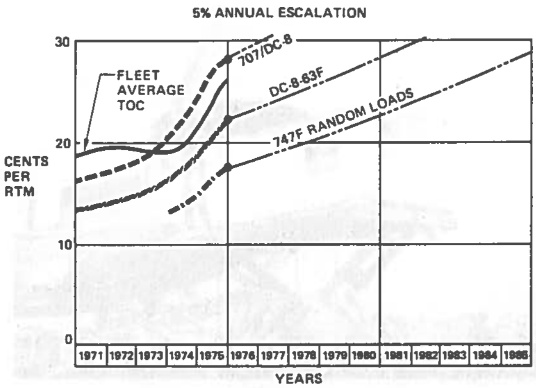
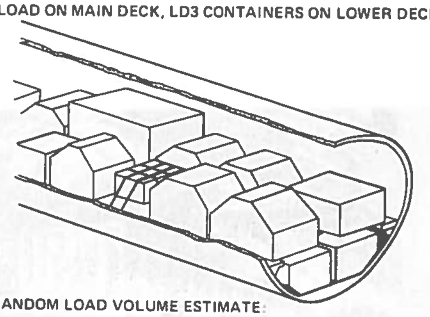


Figure 11 OPERATING COST PROJECTION WITH 5% ANNUAL ESCALATION

RANDOM LOAD ON MAIN DECK, LD3 CONTAINERS ON LOWER DECK



TYPICAL RANDOM LOAD VOLUME ESTIMATE:

18—707/DC-8 IGLOOS	AT 430 CU FT EACH =	7 740 CU FT
6—8- X 8- X 10-FT	AT 575 CU FT EACH =	3 450
4—88- X 64- X 125-IN.	AT 380 CU FT EACH =	1 520
TYPICAL MAIN DECK VOLUME		12 710
30—LD3'S AT 158 CU FT EACH		4 740
TOTAL AIRPLANE VOLUME (TYPICAL)		17 450 CU FT

Figure 12 747 WITH RANDOM LOAD ON MAIN DECK, LD3 CONTAINERS IN LOWER DECK

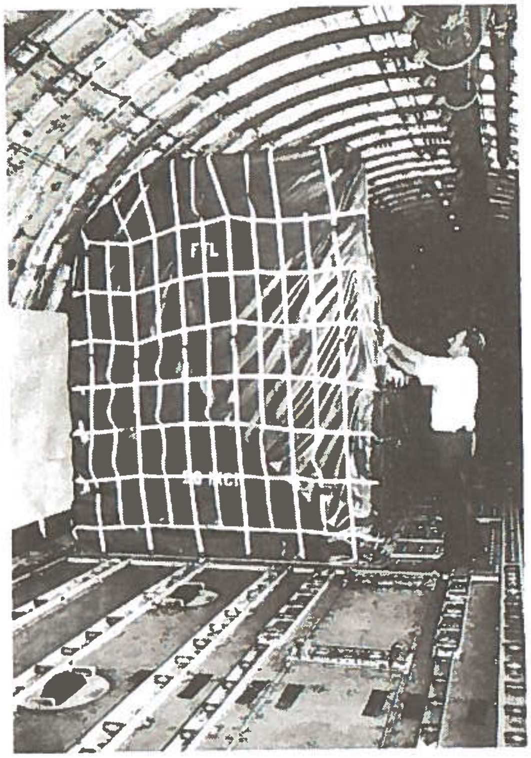
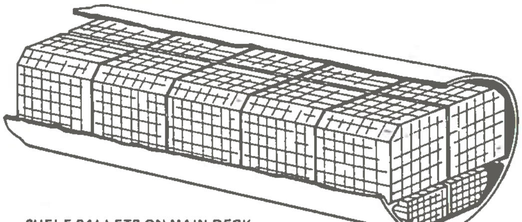


Figure 13 FLYING TIGERS' SHELF PALLET

OPTIMIZED ULD'S ON MAIN DECK, LD3 CONTAINERS ON LOWER DECK



SHELF PALLETS ON MAIN DECK,
LD3 CONTAINERS ON LOWER DECK

TYPICAL VOLUME ESTIMATE:

20—SHELF PALLETS AT 705 CU FT =	14 100 CU FT
9—8- X 8- X 10-FT AT 575 CU FT =	5 175
MAIN DECK VOLUME	19 275
LOWER DECK VOLUME	4 740
TOTAL VOLUME (TYPICAL)	24 015 CU FT

Figure 14 747 BODY WITH 118-INCH-HIGH OPTIMIZED ULD'S

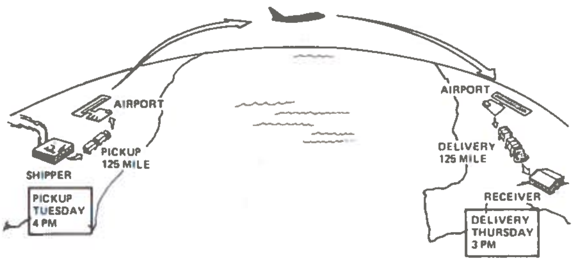
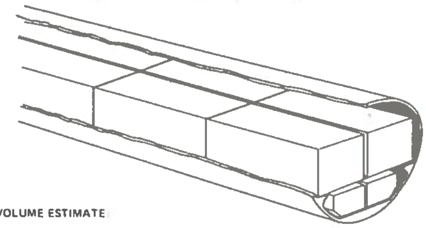


Figure 15 INTERMODAL AIR FREIGHT SYSTEM CONCEPT

INTERMODAL CONTAINERS ON MAIN DECK, LD3 CONTAINERS ON LOWER DECK



TYPICAL VOLUME ESTIMATE:

13 CONTAINERS AT 1150 CU FT EACH	= 14 950 CU FT (69% OF VOLUME IS INTERMODAL)
5 CONTAINERS AT 575 CU FT EACH	= 2 875
TOTAL MAIN DECK VOLUME	17 825
LOWER DECK VOLUME	4 740
TOTAL VOLUME (TYPICAL)	22 565 CU FT

Figure 16 747 BODY WITH 8- BY 8-FOOT INTERMODAL CONTAINERS ON MAIN DECK, LD3 CONTAINERS ON LOWER DECK

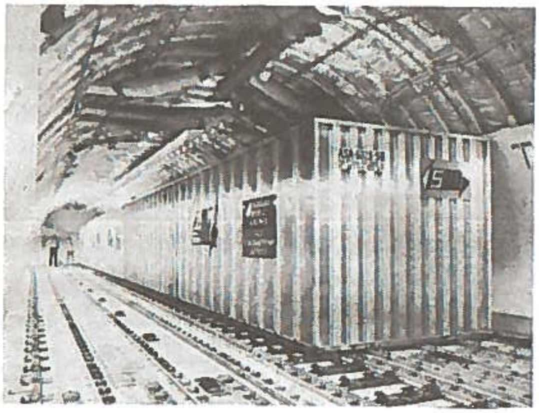


Figure 17 8- BY 8- BY 20-FOOT CONTAINERS IN SEABOARD WORLD AIRPLANE

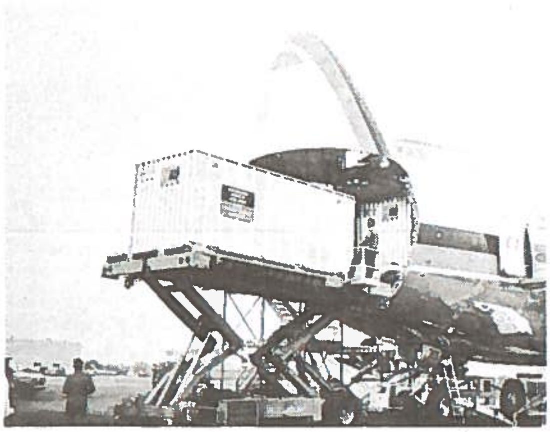


Figure 18 SEABOARD WORLD CARGO LOADING OPERATIONS

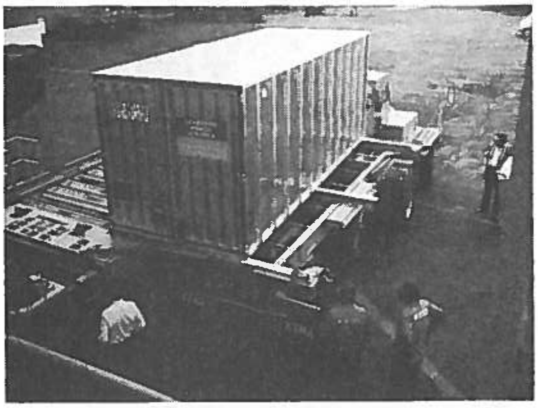


Figure 19 CONTAINER BEING TRANSFERRED FROM SEABOARD WORLD AIRLINES LOADER TO MODIFIED ISO CHASSIS

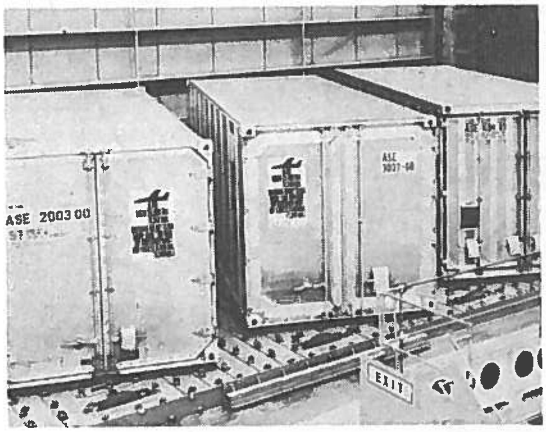


Figure 20 INTERMODAL AIR FREIGHT CONTAINERS

Figure 21 INTERMODAL CONTAINER ON ISO CHASSIS

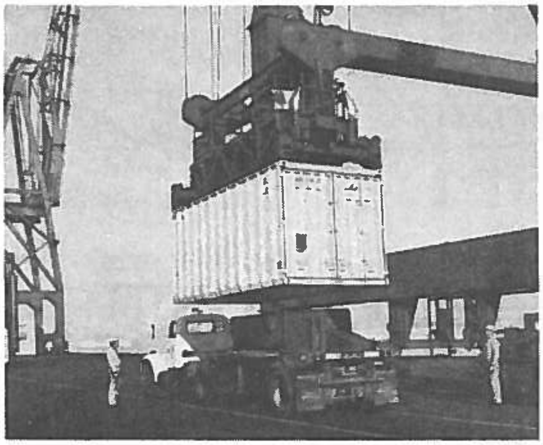


Figure 22 INTERMODAL CONTAINER HANDLING

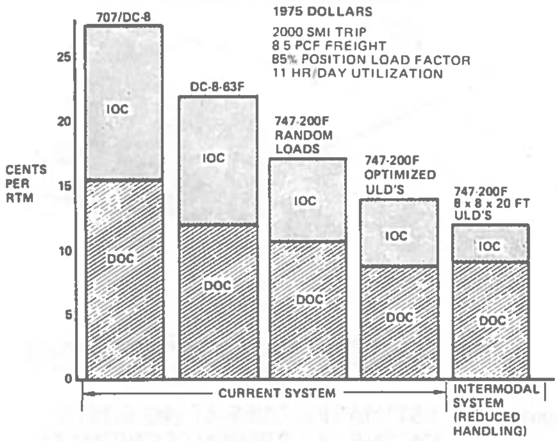


Figure 23 BASELINE OPERATING COSTS

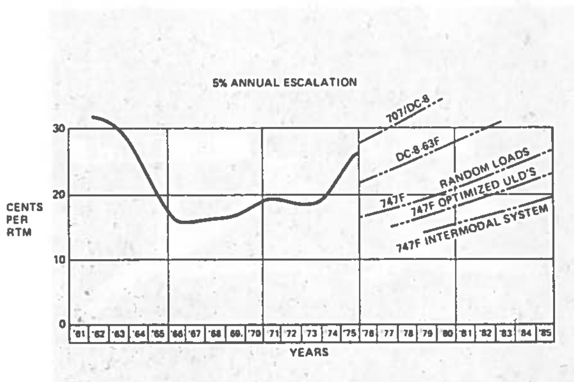


Figure 24 OPERATING COST PROJECTIONS WITH 5% ESCALATION

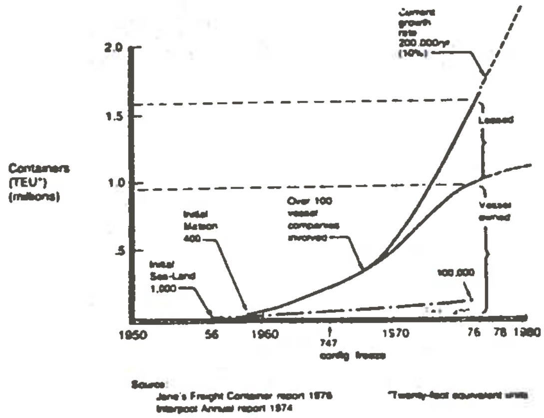


Figure 25 INTERMODAL CONTAINER GROWTH-SURFACE MODES

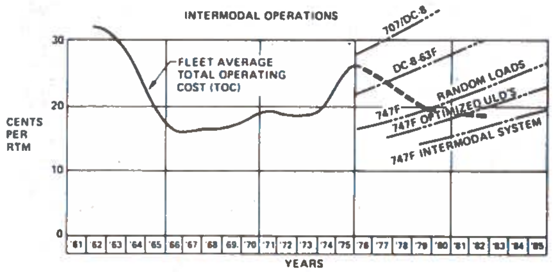


Figure 26 POSSIBLE TREND IN TOC WITH SYSTEM IMPROVEMENTS

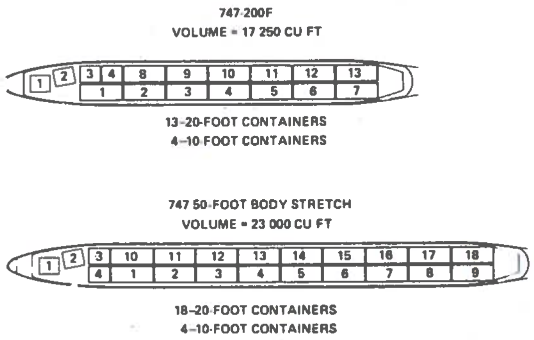


Figure 27 POTENTIAL GROWTH VERSION OF 747F

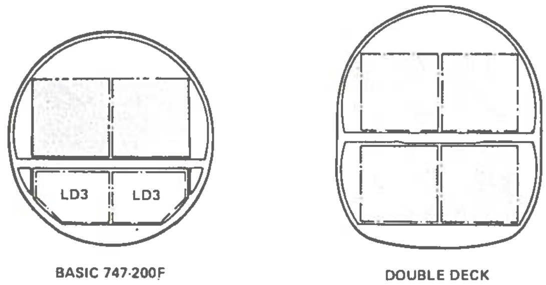


Figure 28 FREIGHTER STUDY CROSS SECTIONS FOR 8- BY 8- BY 20-FOOT CONTAINERS

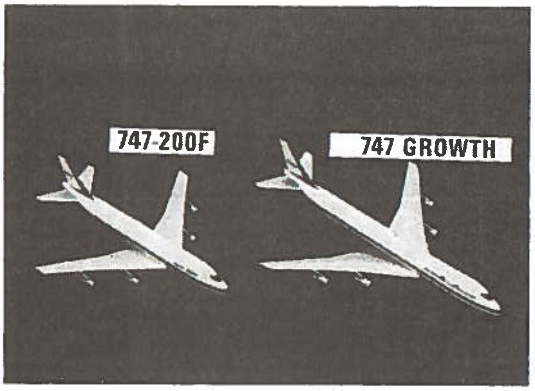


Figure 29 FUTURE 747F POSSIBILITIES

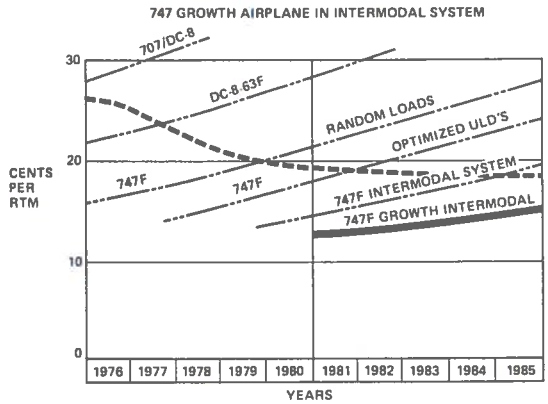


Figure 30 ESTIMATED OPERATING COSTS OF THE 747 GROWTH FREIGHTER AND INTERMODAL SYSTEM

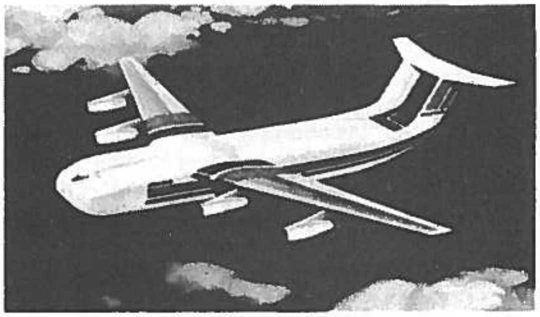


Figure 31 ADVANCED FREIGHTER CONCEPT

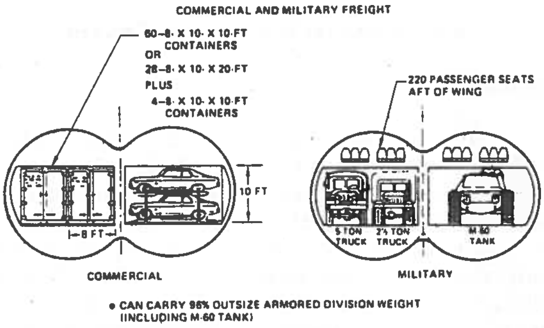


Figure 32 COMMERCIAL/MILITARY PAYLOAD OPTIONS FOR ADVANCED AIR FREIGHTER

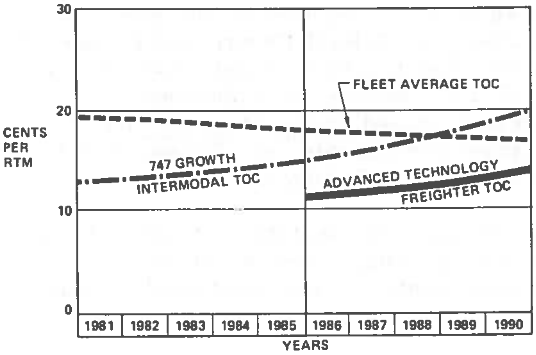


Figure 33 ESTIMATED OPERATING COSTS FOR ADVANCED FREIGHTER

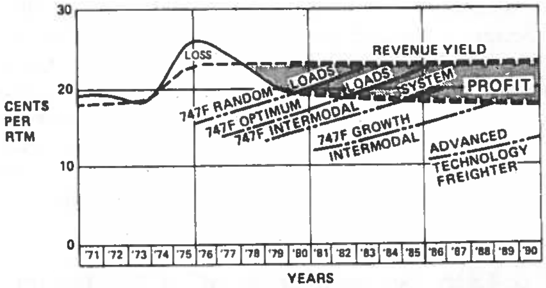


Figure 34 DESIRED COST AND PROFIT PROJECTION

DISCUSSION PANEL

"FUTURE TECHNOLOGICAL DEVELOPMENT IN FREIGHT TRANSPORTATION"

Remarks by
L.A. Brophy
Vice President & Executive Director
Chicago Railroad Terminal
Information System, Inc.

Rail Terminal Information System

Introduction

The first major joint effort by the railroads of America to create a central data collection and information handling system for a railroad terminal was established June 28, 1972, in Chicago, Illinois. The roads which operate in the Chicago Terminal established a not-for-profit corporation, "Chicago Railroad Terminal Information System, Inc." (CRTIS), for the purpose of implementing, operating and administering the joint terminal information system.

A review of how the "Chicago System" was developed and established follows. To identify the Chicago Railroad Terminal it is necessary to look at its size and activities in order to place in perspective the system that was designed to handle the data collection and information for the railroads operating within the terminal. The Chicago Railroad Terminal extends over an area of 1,750 square miles. There are 24 railroads operating on 7,689 miles of track which connect over 100 major freight car classification and support yards. Additionally, there are 80 separate locations where two or more railroads cross each other and over 50 routes that railroads operate on that closely parallel another railroad's track. Located within the Chicago Terminal are over 4,200 industries served by rail. These industries account for a total of 13 percent of the United States freight car loadings, 7 percent of the originating loadings and 6 percent of the terminating loadings. The total loads originating, terminating or moving through the Chicago Terminal account for over one third of the nation's yearly car loadings.

Each day an average of 47,700 freight cars move on 1,400 trains over 1,136 separate point-to-point routes through the terminal. Recognizing the problems of freight car interchange and train movements in the terminal, the operating officers of the Chicago railroads instituted a study in May 1968, to examine the possible joint use of new technologies, improved computer capabilities and automatic car identification to determine if these tools could assist in resolving the terminal problems connected with car interchange between railroads. These major terminal problems were identified as:

Congestion in yards and on routes connecting various yards and railroads.

Lack of communication of advance and current information on cars and trains between railroads.

Availability of reliable information on cars for operating and record-keeping purposes.

Systems Origins

A Task Force was assembled first to determine the feasibility of joint use of automatic car identification scanners for the interchange of cars between roads, and once it was deemed possible, to develop a master plan for a terminal information system for the Chicago Terminal. The Task Force membership included individuals who collectively had experience in transportation operations, data systems, processing, industrial engineering, communications, and signals and operation research.

The master plan for a Chicago terminal information system was submitted to the railroads for their approval in late 1970. The plan was approved and the next step undertaken by the roads was to determine cost and the means to support the system. Bid specifications for all the system's site construction, equipment and services were submitted in early 1971 to all companies interested in responding. The total cost to implement and operate the system over a five-year period was estimated at $9,000,000. Because the system represented an opportunity to demonstrate a working model of a railroad terminal information system, the Federal Railroad Administration, Department of Transportation of the Federal Government, responded to the requests of the Chicago railroads and offered to share the cost of the system with the railroads. The Federal Government's share of the total cost amounts to one third, $3,000,000; the balance of the expense of $6,000,000 is being proportionately shared by the railroads of Chicago through their membership in Chicago Railroad Terminal Information System, Inc.

The actual implementation of the "Chicago Terminal System" commenced in October 1972; the system's implementation was completed in August 1974.

Mr. Brophy worked for several rail carriers before joining Chicago Railroad Terminal Information Systems five years ago, bringing with him more than 22 years of experience in operations and executive administration.

System Design/Description

The System's method of data collection, processing and information disbursement has been accomplished by the installation of 109 automatic car identification scanners at 40 different sites in the Chicago Terminal. These optical scanning devices read and transmit as the train passes the scanning device; each unit of equipment that is identified by retroreflective modules affixed to the sides of the equipment is read. Located at the headquarters of Chicago Railroad Terminal Information System, Inc. (CRTIS) is a central processing unit that is interfaced with these scanners and is likewise interfaced by the means of dedicated data lines with the computers and/or various input/output devices of the Chicago Railroads.

Each railroad inputs its car detail information on all cars to be moved in trains within Chicago into CRTIS' computer prior to their movement in the terminal. This waybill type information is wed with the scanned data and the collection and processing of the data provides each railroad with timely output information for its operations.

Specifically, there are four major subsystems to the system. These subsystems are:

1. 109 optical automatic car identification scanners at 40 sites.
2. 10 communication circuits interfacing the scanners with the CPU and 30 dedicated data lines interfacing the railroads' computers and/or various input/output devices.
3. A central processing unit using two front-end processors to handle the communications network and the system processing.
4. Software, the design, logic and programs for the system.

The scanner subsystem is represented by the aci scanner located at track site with its processor housed in an environmental hut within 1,000 feet of the scanner. The scanner reads the retroreflective label affixed to the side of each unit of equipment in the train. The light pulse is decoded and is read to the buffer where the label data, along with the train's direction information, resides until polled by the CPU's front-end processor. The communication's subsystem is comprised of 10 leased circuits with each circuit hubbing a minimum of three scanner sites and/or a maximum of five sites. These circuts are the dedicated communication link between the aci scanners and the CPU's front-end processor. There are 30 leased data lines which link railroad's computers and their various input/output devices with the CPU's front-end processor. The line speeds vary as to the device they support.

The central processor uses the prime front-end processor as its communication message handling interface. The second front-end processor is used as backup to the prime front-end processor. The CPU supports disk, tape drives, high-speed printer and card reader.

The software, design, logic and programs for the system's data collection and information processing for output are made up of four basic functional areas:

Advance consist-outbound check notification.

Certified interchange preparation.

Train passing report transmission.

Data collection, data base reporting.

The system's data processing consists of performing functions within the interactive environment of the terminal's total train activities and the system's support operation which processes periodically the accumulation of the transactions from this environment. The interactive environment functions of this data processing include as input:

1. Receiving car detail data in advance from the originating railroad's computer system.
2. Receiving train header information (train header identified by unique code each of the 1,136 separate point-to-point routes within the Chicago Terminal) from the railroad originating the train.
3. Receiving car initial and numbers from trackside automatic car identification scanners.

For processing and output:

1. Editing and validating car detail header and scanner data.
2. Maintaining a car inventory file from information received from these three separate inputs.
3. Maintaining a train inventory file based on the input of train passings received from the scanner.
4. Notification in advance to the receiving road about cars which are moving toward their yards (advance consists).
5. Sending train passing reports to railroads involved in the train movements as the train operates through the Chicago Terminal area (train passing reports).
6. Maintaining files on loaded cars delivered in interchange for the purpose of notifying each receiving road of the validity of the cars' return (home route).

7. Maintaining statistical data about all moves past scanners in the Chicago Terminal.

The system support functions are the reading of the car, train and scanner files to generate daily the railroads' interchange reports on all cars delivered during the previous 24 hours.

Also, this support function provides the capability of producing specific car movement information to each road on cars of their ownership.

Systems Operation (Example)

This brief background descripion of the means of data collection, processing and information output can best be explained by an example of an interchange train movement between railroads in the Chicago Terminal.

For the purpose of this example, a word picture can be drawn for the interchange movement of a train originating at the Norfolk and Western Railway's Calumet Yard, which is located on the southeast side of Chicago, destined to the Burlington Northern Railroad's Cicero Yard, situated in Cicero, Illinois, which is adjacent to the western city limits of Chicago. The distance between these two yards is approximately 14 miles and the average running time to complete this move is two hours. This train will operate over four different railroads' trackage and cross another seven railroads from its origin to destination yard. En route from Calumet Yard to Cicero Yard the train will pass automatic car identification scanners at six different sites; leaving Calumet Yard the train is successively scanned at Pullman Junction, Forest Hills, Hayford Junction, 55th Street, Hawthorne and Cicero before teminating at the Burlington Northern's Cicero Yard.

The delivering road, Norfolk and Western, will input in its own format the car detail data corresponding to all cars that will be offered in interchange within the Chicago Terminal. The car detail information includes the car initial and number, car type, contents, commodity, destination and routing of the car. This information is input directly to CRTIS' central processing unit prior to the interchange movement of the cars out of the Norfolk and Western's Calumet Yard.

Before the train leaves Calumet Yard, the Norfolk and Western inputs a header card directly to CRTIS' cenral processing unit. The information contained in this header card is:

1. Unique two or three alpha code for the point-to-point route. This code indicates the origin railroad and yard and the destination yard and railroad.

2. Locomotive and caboose numbers.

The train departs Calumet Yard and is initially scanned at Pullman Junction, a distance of one and one-half miles from Calumet Yard. The scanned data is transmitted immediately from the scanner to CRTIS' computer, where this input is related to the prior car detail and header input and an advance consist of the train is transmitted to the Burlington Northern at the same time the Norfolk and Western receives the outbound train check.

The advance consist to the Burlington Northern will indicate the train, its location, time and date and list by initial and number in train order sequence from the engine to the caboose each unit of equipment, plus all available car detail information corresponding to each car on the train.

The Burlington Northern's operating officer will receive this advance consist and it enables him to plan in advance the method of handling the train when it arrives in the yard, reducing potential yard delay on the cars and train. Additionally, the consist alerts the operating officer of cars traveling without waybill information, permitting the development of the necessary information on these cars to keep them moving without delay. The advance consist also provides the Burlington Northern with the information on empty equipment en route which provides the capability of real time awareness of the empties situation.

The outbound train check message transmitted to the Norfolk and Western at the same time the Burlington Northern is receiving the advance consist of the train indicates location, direction, time/date, locomotive, each unit of equipment by initial and number in train order and sequence and the caboose. The Norfolk and Western's operating personnel receive this outbound train check which offers reliable, prompt information on cars on the train that has departed the yard.

The train next passes a scanner at the Forest Hills site and this train passing is transmitted from the scanner to CRTIS' central processing unit, where it is processed and returns a joint train passing message to both the Norfolk and Western and the Burlington Northern. This train passing message identifies the train, its direction, location, time/date, total number of cars in the train and gives in detail any changes in the original consist. The Burlington Northern yard operating personnel receiving this output will be aware of the exact number of cars on the train and when the train can be expected at the yard, thus giving the Burlington Northern yard forces the opportunity to plan the work of bringing the train in without delay. The Norfolk and Western operating officer receiving this output is afforded the capability of keeping constant surveillance over the crew and motive power outside his yard.

At each subsequent intermediate scanner site (Hayford Junction, 55th Street, and Hawthorne) at which the train passes a scanner, the same type of train passing report is transmitted promptly to both the Norfolk and Western and the Burlington Northern, updating the train's location.

The train passes the scanner at the Cicero site and enters the Burlington Northern's Cicero Yard. This activity of the train passing the final automatic car identification scanner provides output to the Burlington Northern in the form of an inbound train check, which lists each car in its train sequence by initial and number from the engine to the caboose. This inbound train check enables the Burlington Northern yard forces to immediately prepare the yard classification list, thus reducing the possible delays to cars that occur on account of a train awaiting classification information. The Norfolk and Western receives a train location message from this scanning at Cicero which indicates to them the train has arrived at the Burlington Northern's Cicero Yard and the cars have been interchanged.

The exact time of the train passing the scanner at Cicero is a valid interchange time on all of the cars on the train. This completes the movement of the train under observation. The activity of this train produces data which is accepted by the system and the program logic of this system enables the assembling of the data from this base in order to additionally produce daily on a specific schedule these output reports to all the railroads:

1. Interchange Document. This report lists by railroad the cars received and delivered in interchange in the previous 24 hours. The report shows time, date, location, railroad, car initial, number, type and load or empty for each car involved in the interchange. This document provides the roads with complete information on all interchange transactions.

2. System Car Location Report. Each road receives this report which represents all of their car ownership by number, type status, load or empty, location and the specific railroad where the car was last scanned in the Chicago Terminal during the previous 24 hours.

3. Empty Cars Received Analysis. Each railroad receives a listing of all empty cars by car initial and number which were received from other railroads during the previous 24 hours, with the last known loaded movement of the car in the Chicago Terminal and the railroads involved in that loaded movement. This report provides a road with total information on empty equipment received in interchange.

There are other in-house accounting reports that the system produces to assist in the administration of the system.

Systems Goals

The Chicago Railroad Terminal Information System was designed and implemented for the purpose of providing accurate, detailed and timely information to all railroads in order for the Chicago railroads to attain the goals of:

1. Reducing the congestion in yards and on routes connecting yards and railroads.

2. Reducing transit time on all cars moving in the Chicago Terminal.

3. Establishing a communication network for the handling and communicating of information between railroads.

4. Centralizing recordkeeping functions on interchange traffic.

5. Reducing the occurrences of cars being held for waybill or routing information.

6. Keeping a constant surveillance over all trains, cars and cargo containers moving into, through and out of the Chicago Terminal.

7. Improving on the utilization of equipment to increase car days available.

The railroads of Chicago have shown by their participation in this system that railroads will work cooperatively and collectively with one another when the benefits of a project are not only in their own self-interest but in the interest of the railroad industry and the public alike.

* * * * *

Question: After counting the wheels, do you divide by eight to get the number of cars? Like counting cows?

Answer: The method of identifying the position of rolling stock in a train is as follows:

A wheel counter installed on the rail immediately in front of the aci scanner commences to count wheels as the aci scanner that has been previously turned on searches out a label. With the finding of a label, the system's logic expects a count of wheels after the read of the label to

Answer: (Cont'd)

signify that it has read a unit of rolling stock. The system logic calls for a pause in reading until the next unit lead wheel actuates the same logic stream. The logic is set for rolling stock which has no greater than six wheel trucks at each end of the rolling stock unit.

In the event a unit of rolling stock label is unreadable or there is no label applied, the system's logic still records by the use of zeros to indicate the location of the unit in the train. The reading of each unit of rolling stock is chained in sequence of read within the decoder's buffer until the last unit has cleared the wheel counter. At this point, the buffer is prepared to transmit the train when polled by the computer.

Question: What improvements in the interface between rail and truck are contemplated or needed, and how important is improvement in this interface?

Answer: The present optical, automatic car identification scanning system can read trailers and containers that are on flat cars, and the scanning system logic associates the trailer with the flat car. The output information is formatted either by indicating on the same line as the flat cars' initial and number the initial and number of the trailers on the flat cars, or the output is formatted by indicating the flat cars' initial and number on a single line and the following lines listing the trailers on the flat cars by initial and number. At present, the system of trailer and/or container identification interfaced with the rail unit is sufficient for purposes of reporting.

As for the actual handling of trailers on flat cars, in major terminals greater emphasis must be placed by the railroad of interchanging trailers on flat cars within the terminal instead of the now common practice of handling most trailers for interchange to another railroad by detraining the trailer and then moving it on city streets and expressways to the next railroad for their placement of these trailers onto flat cars for departure from the terminal.

DISCUSSION PANEL

"FUTURE TECHNOLOGICAL DEVELOPMENTS IN FREIGHT TRANSPORTATION"

Remarks by
M.D. Meeker, Jr.
Manager, Railroad Electrification
General Electric Company

Railroad Electrification for Freight Movement in the 80's and 90's – Available Now!

Railroad electrification will contribute significantly to the efficient operation of America's freight system in the 80's and 90's. Electrified railroad operation has become of vital importance to most of the world's railways and is becoming increasingly important for North American railroads. A quick look at the world (Figure 1) shows that everywhere outside the North American continent electrification has become the standard way to expand high-volume main line railroads. You will note that many industrialized countries have converted between 25 and 30 percent of their total mileage, this generally the high-density routes which carry well over half their tonnage. Note that the Soviets lead the world with about 25 percent of their route structure electrified, and that 25 percent carries 40 percent of their freight. Their goal is 40 percent of their route structure that carries over 80 percent of the freight. In addition to these industrialized nations, there is substantial present activity among the developing nations, both the oil-poor ones, such as South Africa, Brazil, and Taiwan, who recognize the need to be petroleum independent, and the oil-rich ones, such as Iran, who recognize electrified rail operation as the modern, efficient method for freight transport.

There are several reasons why other nations moved ahead of us in electrification. Until the late 1960's traffic densities on American railroads didn't reach levels which made electrification economical. In addition, the electric supply systems and electric locomotives in use on early electrifications were just not advanced enough in technology to be competitive with the highly efficient diesel electric operation which developed in the United States after World War II. Now, however, the available 25KV or 50KV overhead lightweight catenary systems using commercial frequency power in combination with solid state rectifier and thyristor control provide the competitive system required.

To illustrate this, we look at a comparison between the diesel electric and a modern electric locomotive. Figure 2 shows a basic diesel electric locomotive. The shaded areas are strictly related to the diesel locomotive and include some 3,000 moving, wearing parts, plus numerous filters and strainers which must be maintained at frequent intervals. In an electric locomotive, as can be seen in Figure 3, the diesel-related parts are replaced by relatively simple, easily maintained, mostly static, rugged components.

It's the simplicity, ruggedness, and ease of maintenance of the electric that leads to the advantages shown in Figure 4. Without having to carry its own prime mover on its back, the electric can provide substantially more horsepower per unit than can the diesel, and also at a lower unit horsepower cost than the diesel. The electric locomotive has one third the maintenance cost of a diesel, twice the life, and a substantially higher availability for service.

The one deterrent to electrification in the United States is the initial investment required in the fixed facilities. These can total over $120,000 a track mile made up, as shown in Figure 5, of $60,000 to $80,000 per mile for catenary, $10,000 to $20,000 for substations, $5,000 to $20,000 for necessary signal modifications, and $5,000 to $20,000 for necessary modifications to the communications system. For a 1,000-mile railroad, this would mean a fixed plant initial investment of approximately $120 million. However, the typical return on that investment for a high-density line carrying more than 30 million tons of freight a year is 20 to 25 percent. Hence, although the initial investment is relatively large, it produces substantial ongoing operating savings as depicted in Figure 6.

There are reasons other than economic ones for electrification of the high-density railroad segments in this country. One of these, of course, is the energy situation. First, as Figure 7 shows, railroads provide the most energy-efficient mode for moving freight. And electrified railroads provide the only energy alternative to petroleum for transportation since the electricity supplied to them can be generated from the more abundant coal, nuclear fuel, or hydropower.

Routes making up 10 percent of the U.S. railroad system, about 22,000 miles, are viable candidates for electrification. These are the high-density routes carrying over 50 percent of the tonnage. If this 22,000 miles were now electrified, two billion gallons of diesel fuel could be saved annually. That figure will rise to three billion

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Mr. Meeker has over 10 years of line management experience in engineering and marketing in the area of railroad electrification. He is currently managing a marketing operation dedicated to the growth of railroad electrification and the worldwide sale of and application of electric locomotives.

gallons by 1980 just due to normal load growth on the routes.

The major purpose of this conference is to explore the technology needed for efficient freight movement in the 80's and 90's. This technology is available for application now. The advances made in the 60's and early 70's are predominately responsible for making railroad electrification presently viable. In the late 50's the introduction of the rectifier on the 4000-horsepower New Haven locomotive shown in Figure 8 made possible for the first time the direct use of commercial frequency power with its inherent economies. The switch from mercury arc rectifiers to the more reliable and smaller silicon diodes in the sixties permitted the 4400-horsepower E44 locomotives (Figure 9). As shown in the circuit diagram (Figure 10), these locomotives used transformer secondary tap changing to achieve the adjustable motor speed required.

The modern era was really ushered in in 1968 when the first commercial frequency electrification in the United States was installed by American Electric Power on their new 15-mile Muskingum electric railroad in southeastern Ohio (Figure 11). The catenary of modern, simple design as shown in Figure 12 is energized at 25,000 volts, 60 hertz. A substantial improvement in locomotive technology was achieved by the application of thyristors on the E50, 5000-horsepower Muskingum Electric Locomotives (Figure 13). As shown in the circuit diagram (Figure 14), the thyristors eliminated the electromechanical tap changer formerly necessary on diode rectifier locomotives. The Muskingum locomotives also introduced the use of an on-board vacuum circuit breaker which could be made small enough to make practical catenary voltages even higher than 25KV.

Present state of the art is represented by the 50,000-volt, 60-hertz Black Mesa and Lake Powell Railroad (Figure 15). This railroad provides the blueprint for the modern electric railroad of the 80's and beyond. Thirteen-thousand-ton, 77-car-unit coal trains travel 80 miles at the relatively high speed of 55 miles per hour to bring coal from the Black Mesa Mine near Kayenta, Arizona, to the large new Navajo Power Station at Page (see map, Figure 16). The railroad is the first in the world to operate at 50,000 volts, double the highest voltage used elsewhere. The operation of this railroad is certainly representative of U.S. main line operation. Therefore, the experience gained on the BM&LP is directly applicable to the electrification of main lines.

It's instructive to look at some of the features of this railroad. First, operation at 50,000 volts, while requiring somewhat increased electrical clearance over the lower 25KV, provides the benefits of lower catenary currents with substantially lower voltage drop allowing a doubling of the spacing between substations with lower system losses. Three years of trouble-free current collection on the BM&LP prove the present practicality of 50KV electrification.

In considering any electrification, a number of power supply factors must be analyzed. These are summarized in Figure 17 and include voltage and load characteristics, electrical demand on the system, power factor of the vehicles, the harmonic generation by the vehicles and its effect on both propulsion and electromagnetic interference, and also analysis of the unbalance created by the single-phase operation on a three-phase utility system. Proved methods (Figure 18) are available for these analyses thanks to adaptation of analytical tools which have been available for some time for the analysis of electric utility power transmission and distribution systems.

The features of the freight locomotives of the 80's are typified by the features of the E60C, 6000-horsepower locomotives (Figure 19) hauling the Black Mesa and Lake Powell trains. First a look at the significant features of the current collection equipment on the roof (Figure 20), specifically the pantograph and the vacuum circuit breaker. A great deal of work has been done over the last decade in making current collection from an overhead wire more reliable and practical at higher speeds. The Faiveley pantograph shown in Figure 21 is a modern result of much of this effort and is successfully applied at speeds up to 120 miles per hour.

The application of vacuum technology was necessary to make a circuit breaker of reasonable size to permit the higher 50,000-volt operation. This vacuum breaker shown in Figure 22 has been specifically designed for the locomotive application.

Next, we look at improvements in thyristor technology. Note in Figure 23 the compact, simple, air-cooled subassembly of pressure-mounted cells. The subassemblies bolt very simply onto an air plenum as shown in Figure 24. The thyristor power circuit as shown in Figure 25 can be made independent for each truck of the locomotive and provides extremely smooth acceleration over the entire speed range.

Finally, an individual axle wheelslip control is a recent development which allows the more effective utilization of the increased power available on an electric locomotive. When the wheel of a locomotive starts to slip, the coefficient of friction between wheel and rail drops quite rapidly, thereby unloading the traction motor. Ideally, one would like to reduce the available motor torque very rapidly on only the slipping axle to bring it back to a rolling condition while still maintaining highest available torque on the other nonslipping axles of the locomotive. The individual axle control applied on the Black Mesa locomotives permits this for the first time.

Worthwhile development, of course, is a continuing endeavor as we plan not only for the next decade or two but for the years beyond. Such development, under way now in the world, includes new propulsion power conditioning systems including thyristor systems to provide adjustable frequency three-phase A-C power to make practical the use of A-C traction motors which can provide more power in the same space. In addition, development continues in the areas of power factor improvement and telephone interference factor improvement, all aimed at making electric railroad operation more efficient and less costly.

However, the products and techniques are available now to provide the desired transportation of this nation's freight in the 80's and 90's with priorities assigned such that the freight is moved by those modes that can provide most efficient service with minimum exploitation of our limited national resources. Railroad electrification, available now, will make a major contribution to the railroads' efforts to provide a fast, economical, petroleum conserving freight transportation network across our country.

* * * * *

Question: Why is electric ROW so ugly? It looks like elevated rapid transit. Can power be buried, can towers be made more pleasing to look at?

Answer: As to the aesthetic qualities of the railroad electrification right-of-way, it's been our experience that electrification can blend well with the surrounding environment. Consider, for example, the high value of the residential Philadelphia main line. Another example of excellent harmony between modern electrified systems and the surrounding environment is the country of Switzerland which has over 99 percent of its railroad electrified.

One of the reasons that an electrified railway is more aesthetic than one not electrified is that generally the open wire communication lines must be replaced with buried cable because of the technical aspects of the electrification. Hence, the rather cluttered telegraph lines and poles are replaced by the modern, neat, clean, cantilevered catenary.

Question: Have you looked at flywheel technology to replace diesel – electric? Or to extend or make easier to implement standard electrification – not only steel but S-glass composition, high-speed, run in partial vacuum, and so forth?

Answer: General Electric operates an advanced research and development facility near Albany, New York, where we are continuously searching for new technological breakthroughs to improve our many products and systems. Such concepts as flywheel technology and linear motor propulsion systems have been evaluated, as well as many other forms of energy generation, transmission, distribution, and conversion for transportation and other uses. In all our development efforts, we have yet to find a bulk commodity transport mode which exceeds the energy efficiency and other economies of the steel wheel, steel rail concept.

Question: I understand that several carriers, including Burlington Northern, have undertaken detailed studies concerning the feasibility of electrifying high-density portions of their systems. Are you acquainted with any of the results of these studies? What would be the rate of return on any given project and would it be enough to compensate for the risk involved, assuming capital is available to invest?

Answer: You understand correctly that several major railroads, including the Burlington Northern, have undertaken detailed studies of the feasibility of electrification. Nearly all of such studies have yielded very favorable results. We have found that the projected rates of return for these various studies range between 20 and 30 percent with some projects showing even higher returns. It is not the rate of return that has discouraged the prime candidates from making the commitment, and this has been confirmed by many railroads. It is really the difficulty the railroad industry has in generating sufficient capital for a major electrification project when it has far more urgent requirements for its limited funds. Hence, regardless of how good the payoff is in electrification, the investment in it is discretionary when compared to such mandatory expenditures as maintaining the track structure in operable condition.

It is in the finance area that some especially creative financing approaches are needed to get electrification moving. These probably will also require some federal government encouragement or involvement such as liberal investment tax credit and depreciation allowances, guaranteed loans, and perhaps grants.

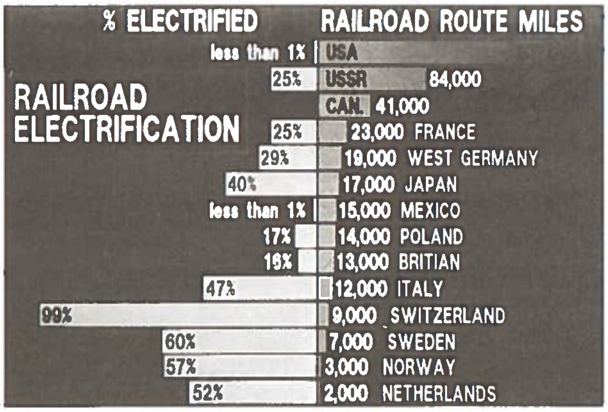

FIGURE 1
WORLDWIDE ELECTRIFICATION

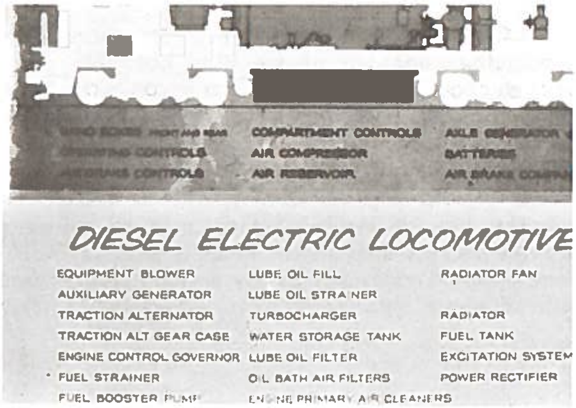

FIGURE 2
BASIC DIESEL ELECTRIC LOCOMOTIVE

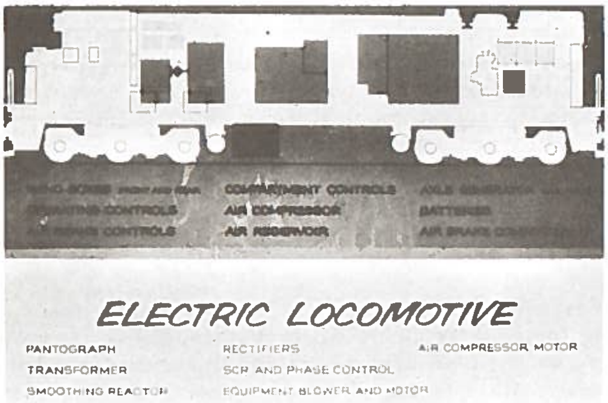

FIGURE 3
BASIC ELECTRIC LOCOMOTIVE

ADVANTAGES OF ELECTRIFICATION

	ELECTRIC	DIESEL-ELECTRIC
HIGHER HORSEPOWER	8,000 HP	5,000 HP
LOWER COST	85 %	100 %
LOWER MAINTENANCE	33 %	100 %
LONGER LIFE	100 %	50 %
GREATER AVAILABILITY	95 %	90 %

FIGURE 4
ADVANTAGES OF ELECTRIFICATION

RAILROAD ELECTRIFICATION COSTS

	$ PER TRACK MILE
CATENARY	$60,000 - 80,000
SUB-STATIONS	10,000 - 20,000
SIGNALS	5,000 - 20,000
COMMUNICATION	5,000 - 20,000

FIGURE 5
RAILROAD ELECTRIFICATION FIRST COSTS

Railroad Electrification
COMPARATIVE CASH DISBURSEMENT

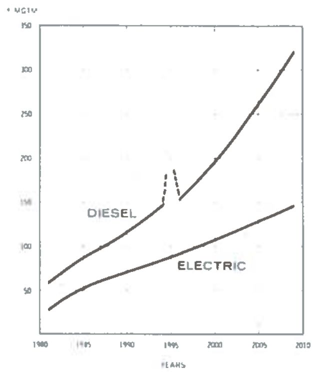

FIGURE 6
COMPARATIVE CASH DISBURSEMENT

STEEL WHEEL		
WALL STREET JOURNAL MAY 1974	SP TRAINS	238 TON MI/GAL
	TRUCK	59.5 TON MI/GAL
	AIRPLANE	1.9 TON MI/GAL
AUTOMOTIVE INDUSTRIES APRIL 1974	ELECTRIC RAILWAY	320 BTU's/TON MI
	TRUCK	2300 BTU's/TON MI
	AIRPLANE	37000 BTU's/TON MI
ICC STATISTICS 1970	RAILWAYS	190 TON MI/GAL
	TRUCKS	60 TON MI/GAL
	AIRPLANE	3.5 TON MI/GAL
RAND CORPORATION 1967	RAILWAY	750 BTU's/TON MI
	TRUCK	2400 BTU's/TON MI
	AIRPLANE	63000 BTU's/TON MI

FIGURE 7
STEEL WHEEL, COMPARATIVE
ENERGY EFFICIENCY

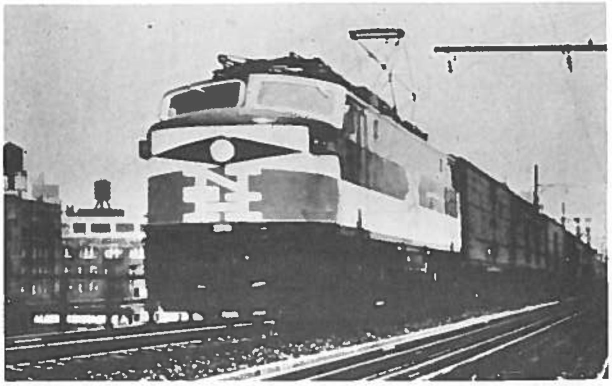

FIGURE 8
NEW HAVEN EP5, IGNITRON RECTIFIER
LOCOMOTIVE, 4000 HP, 11 KV, 25 HZ

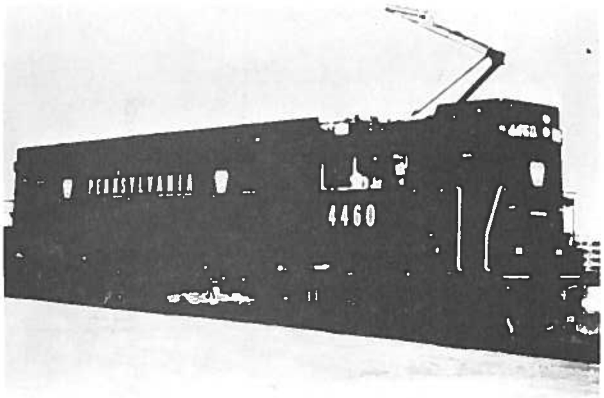

FIGURE 9
PENNSYLVANIA E44, DIODE RECTIFIER
LOCOMOTIVE, 4400 HP, 11 KV, 25 HZ

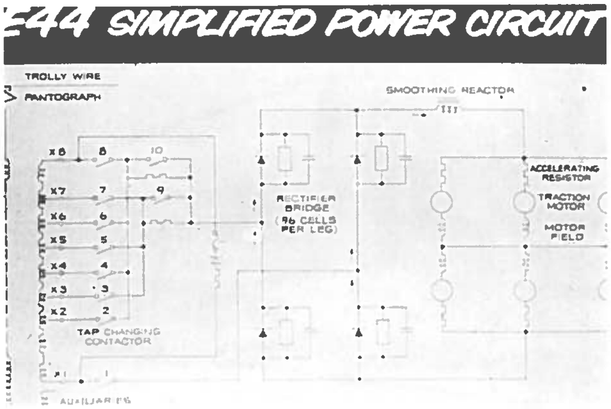

FIGURE 10
E44, 4400 HP ELECTRIC LOCOMOTIVE,
POWER CIRCUIT

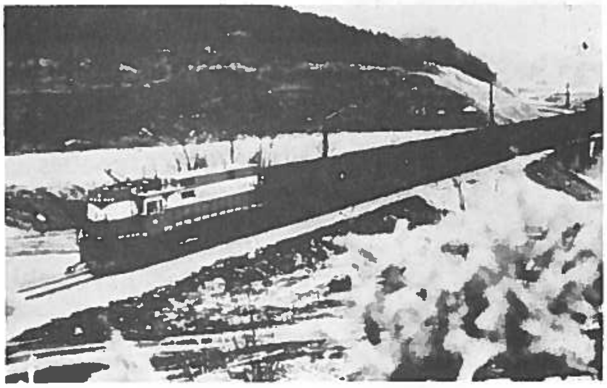

FIGURE 11
MUSKINGUM ELECTRIC RAILROAD,
UNIT COAL TRAIN

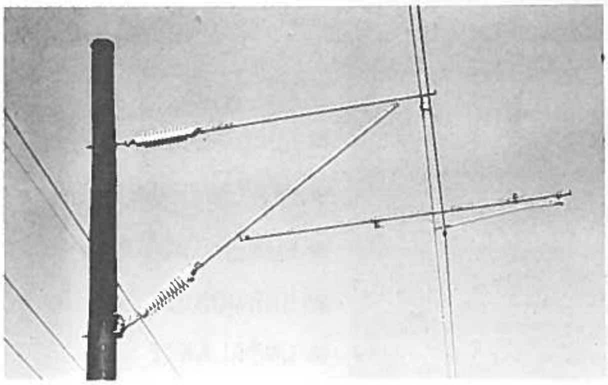

FIGURE 12
MODERN SIMPLE CATENARY CONSTRUCTION

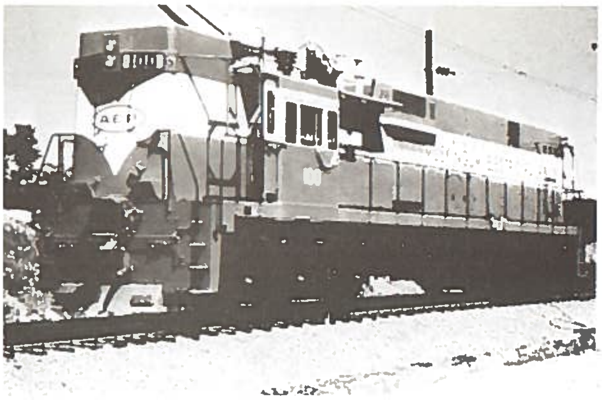

FIGURE 13
MUSKINGUM E50, THYRISTOR ELECTRIC
LOCOMOTIVE, 5000 HP, 25 KV, 60 HZ

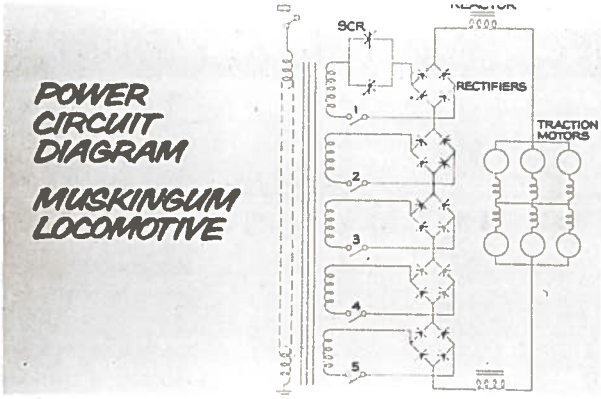

FIGURE 14
E50, 5000 HP ELECTRIC LOCOMOTIVE,
POWER CIRCUIT

FIGURE 15
BLACK MESA AND LAKE POWELL RAILROAD,
13,000 TON, 77-CAR UNIT COAL TRAIN

FIGURE 16
BLACK MESA AND LAKE POWELL RAILROAD

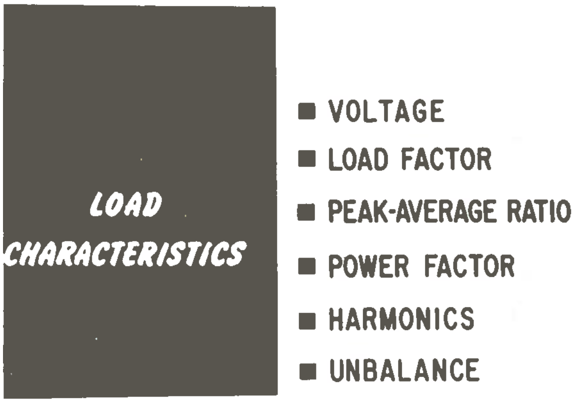

FIGURE 17
RAILROAD ELECTRIFICATION,
ELECTRICAL LOAD CHARACTERISTICS

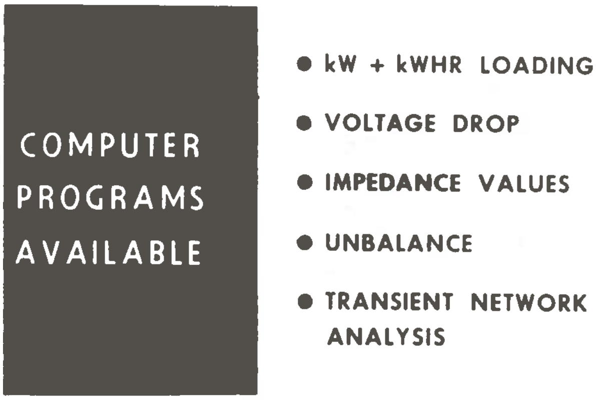

FIGURE 18
RAIROAD ELECTRIFICATION,
ANALYTICAL METHODS AND TOOLS

FIGURE 19
BLACK MESA AND LAKE POWELL E60,
THYRISTOR ELECTRIC LOCOMOTIVE,
6000 HP, 50 KV, 60 HZ

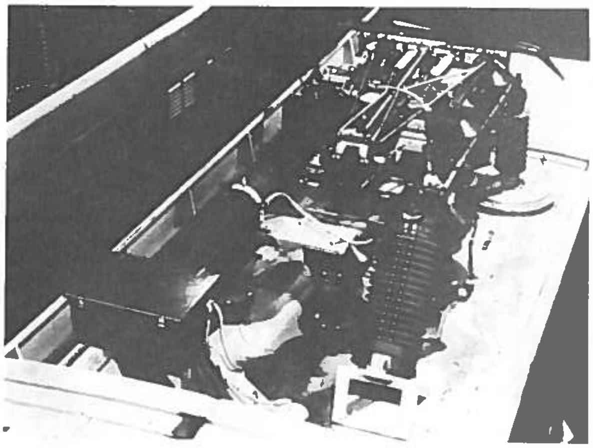

FIGURE 20
E60, 6000 HP, 50 KV, 60 HZ LOCOMOTIVE,
HIGH-VOLTAGE ROOF EQUIPMENT

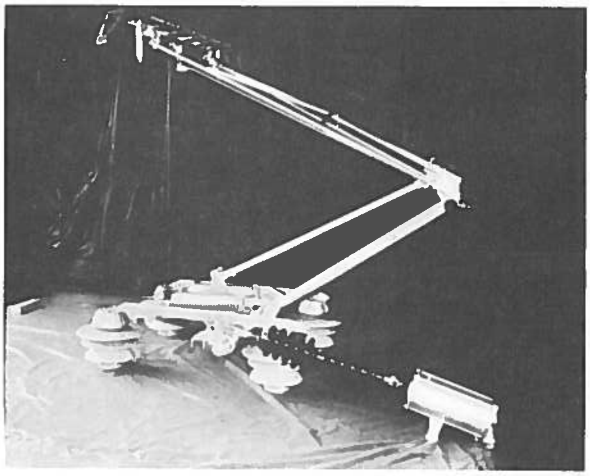

FIGURE 21
FAIVELEY SINGLE-ARM PANTOGRAPH

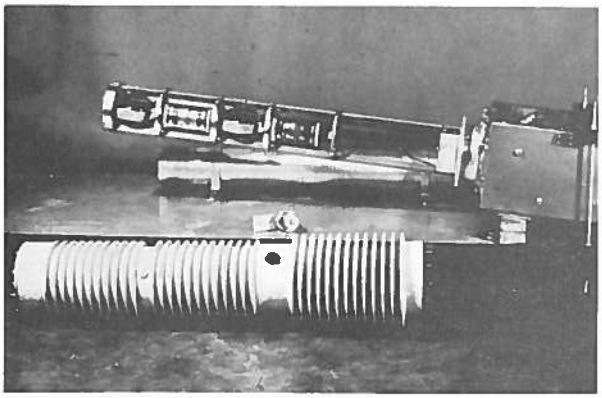

FIGURE 22
LOCOMOTIVE VACUUM CIRCUIT BREAKER

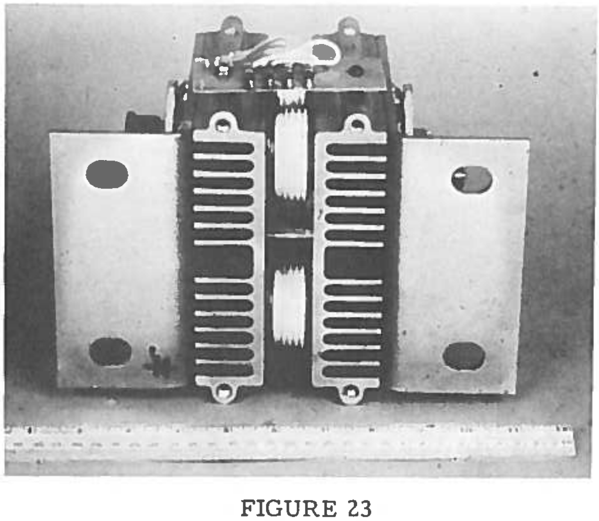

FIGURE 23
"PRESS-PAK" THYRISTOR SUBASSEMBLY

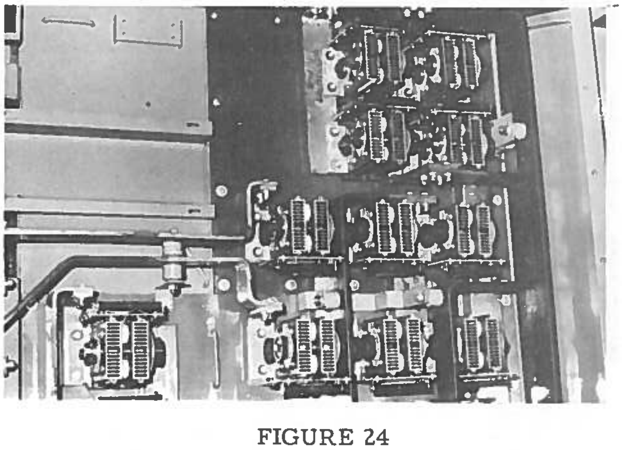

FIGURE 24
E60, 6000 HP ELECTRIC LOCOMOTIVE
THYRISTOR POWER ASSEMBLY

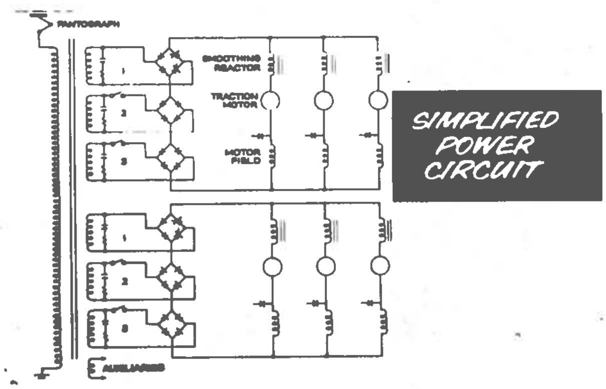

FIGURE 25
E60, 6000 HP ELECTRIC LOCOMOTIVE, POWER CIRCUIT

DISCUSSION PANEL

"FUTURE TECHNOLOGICAL DEVELOPMENTS IN FREIGHT TRANSPORTATION"

Remarks by
A. N. Addie
Advance Engineering Manager
Electro-Motive Division
General Motors Corporation

The Future Trends in Railroad Motive Power in the United States

Introduction

The future of motive power for the United States railroads is dependent on a number of factors, some of which relate to the inherent advantages of the rail mode in transporting freight efficiently with respect to energy usage, with minimum pollutant emissions, and with minimum labor requirements. The influence of certain negative factors must also be considered, among which are the deteriorated condition of much of the railroad track in the United States, the work rules which apply to train crews, the delays in terminal freight yards, the Federal Government regulations on freight rates, and the abandonment of non-economic routes.

This paper will also present a review of the growth of diesel motive power, its current status in regard to efficiency in the utilization of petroleum fuels, its contribution to the goal of reduced pollutant emissions and its prospects for future development. In addition, the relative advantages and disadvantages of the principal competitor to the diesel, the electric locomotive, will be discussed and its potential as a technological tool for improving the quality of freight transport will be assessed.

Characteristics of the Rail Mode

It has been frequently said that from the energy consumption viewpoint the steel wheel on the steel rail is the optimum mode of traction for earth-bound vehicles. The locomotive-hauled freight train is the prime example of this form of traction. Figure 1 shows the relative resistance on level terrain of several freight transportation modes. It is apparent that the long freight train exhibits the lowest tractive resistance and, therefore, will require the minimum tractive energy per gross ton mile at any average speed. The ratio of the net tons of freight carried per gross vehicle weight is also an important factor to consider. Typical values of this ratio for different modes of transportation are given in Table I.

The unit train using 100-ton (130 tons total weight) cars indicates most efficient use of the conveying vehicle.

In terms of energy consumed per net ton mile of freight, railroads excel. Table II shows generally accepted values of the range of energy efficiencies of the various intercity transportation modes.

The clear advantage of the rail mode is shown, especially in the cases of the loaded 100-car freight train and unit train. Rail freight transportation has about a 3/1 advantage over highway intercity freight and closely matches the pipeline and barge, with the additional advantage of much greater flexibility of route.

In 1975, United States Class I railroads carried 761,000 x 10^6 ton miles of intercity freight. As shown in Figure 2, this amounted to 49.2 percent of the total intercity freight. The petroleum fuel consumed by the various intercity freight modes is shown in Figure 3. Energy consumed in the intercity rail freight mode in 1975 was about 3313 x 10^6 gallons of diesel fuel.

In 1975, the rail mode made use of 200,000 route miles using a fleet of 28,524 locomotives to haul 1,723,605 freight cars. The average freight train consisted of 68.6 cars, each weighing 61.2 tons, for a gross trailing load of 4,198 tons.

In comparison with the intercity freight modes fueled by petroleum, the rail mode used only 23.7 percent of the total fuel while handling 49.3 percent of intercity freight traffic (excluding pipelines).

A brief comparison of European and American railroad freight practice is instructive to appreciate the fundamental differences which exist.

In Europe, passenger service accounts for a major part of railroad operation and motive power has been designed to satisfy the requirements for rapid acceleration, high speed, with light trains using a 20-metric ton axle load. Freight traffic is mixed with passenger traffic and freight trains of over 1000 tons are seldom dispatched and rarely require the use of multiple locomotive units. In the United States, on the other hand, railroad freight traffic is dominant and long trains (Figure 4), sometimes of 100 or more cars, weighing a total of 15,000 tons, and requiring as many as seven 3000 horsepower locomotive units, are employed. Dis-

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Mr. Addie has been associated with GM's Electro-Motive Division for 30 years where he has been involved in a wide variety of advanced engineering projects. Recently, he has been active in the technological development of regenerative gas turbines, electric rail cars, and electric locomotives.

tances are great and acceleration is relatively unimportant. Major emphasis is placed on trip reliability and failure to negotiate the ruling grade because of insufficient adhesion is intolerable.

Diesel-Electric Motive Power

Diesel-electric locomotives are by far the dominant form of motive power on American railroads, accounting for 99.17 percent of the present fleet. The diesel-electric locomotive was introduced for switching service as early as 1918 and had a relatively slow growth (Figure 5) until the end of World War II when accelerated application occurred. By 1958, the United States railroads were virtually completely dieselized, with the total number of units in service remaining relatively constant at about 28,000.

For freight operations, three general locomotive types are most commonly used; the general purpose locomotive, a four-axle, 260,000 pound, 2000 horsepower unit for multiduty main and secondary line service (Figure 6); a four-axle, turbocharged, general purpose, 3000 horsepower unit designed for a full range of main line freight operations (Figure 7); and a six-axle, 3000 horsepower, heavy-duty freight locomotive for main line, high tonnage operations (Figure 8).

The six-axle, 3000 horsepower, heavy-duty freight unit illustrates the advanced level of diesel-electric locomotive development in terms of tractive capability, efficiency, reliability, and low maintenance achieved only in the United States. The tractive capability of this locomotive is illustrated in Figure 9, showing the characteristic constant power tractive effort curves corresponding to eight throttle positions, with a minimum continuous full power speed of 11.1 miles per hour and a maximum speed of 65 miles per hour; maximum continuous tractive capability of the locomotive under the wide variation of adhesion conditions is about 21 percent of the locomotive weight, or 83,000 pounds.

The energy conversion efficiency of the diesel-electric engine and transmission system is presented in Figure 10. It can be seen that the full-power conversion efficiency of 31.0 percent is available over the speed range of 20-65 miles per hour and that the part-load energy conversion efficiency exceeds 30 percent over a broad range. This excellent efficiency characteristic reflects the high efficiencies of the engine and electrical transmission and the minimization of auxiliary loads. It is unmatched by any other known propulsion system in the world today.

In addition to its excellent energy conversion efficiency the diesel-electric locomotive has enviable pollutant emission characteristics. Based on a heavy-duty cycle, current 2000 horsepower Roots blown and 3000 horsepower turbocharged locomotives manufactured by Electro-Motive have the emission characteristics as shown in Figure 11.

Future Trends in Diesel-Electric Motive Power

The diesel-electric locomotive with its current power conversion and transmission components has evolved over the past 40 years in the United States into a highly efficient, low maintenance, low cost, long life system.

Improvements in the full-load thermal efficiency of the turbocharged, two-cycle diesel engine are still possible. Any restriction placed upon the emission of oxides of nitrogen are likely to adversely affect the performance of the engine. Figure 12 shows the growth in power rating of the Electro-Motive 16-cylinder locomotive over the years and the anticipated level of 3800 brake horsepower to be attained in the next five years.

The auxiliary loads and transmission component losses in a modern diesel-electric locomotive are shown in Table III. In a typical diesel-electric locomotive, the auxiliaries require about 7.5 percent of the power developed by the engine for cooling the engine and electrical machinery. Future improvements in the component efficiencies have a direct impact on the auxiliary power and will result in overall improvement in the locomotive performance.

It is possible that the current AC-DC electrical transmission used in modern diesel-electric locomotives will ultimately be displaced by a higher efficiency AC-AC system. Two systems are currently being studied intensively, both in the United States and Europe. The first makes use of an electronic switching device known as a cycloconverter to convert AC current generated by the main alternator to a three-phase, variable-frequency supply for synchronous AC traction motors. The second makes use of a variable-frequency inverter working from the rectified output of the main alternator to supply three-phase current to induction traction motors. The increased capacity, higher efficiency AC traction motors used in these systems are attractive and would also eliminate the present DC motor commutator and its attendant maintenance. Although the technology of solid-state power electronics exists today to design a variable-frequency AC system, the cost of such a system is much greater than the current AC-DC system and must be more than offset by improved efficiency and lower maintenance to make adoption of the AC-AC system economically justifiable.

Diesel-electric locomotives in the United States have evolved as the optimum solution to the requirements for railroad freight motive power. The direction of this design evolution has been influenced by the requirements and restraints of the American freight rail mode. Notable factors include the allowable axle load of 65,000 pounds (29.5 metric tons); the large loading gauge of 10 feet, 6 inches width by 15 feet height; the economy of long trains which require large tractive effort capability for the ruling grade and high power capability for speed. These restraints, coupled with prime mover and transmission development for efficiency and reliability by unified manufacturers, have resulted in freight locomotives reaching a power level of 3000 horsepower on four axles. At these levels of power it is possible to exploit the allowable axle load under widely varying track conditions to obtain tractive effort equivalent to 18 to 20 percent adhesion. Additional power cannot be utilized at low speed without improvement in wheel-to-rail adhesion. Adhesion can be improved to the 25 percent level using advanced wheel creep control systems now being evaluated, thereby permitting an increase in power to about 3500 horsepower on four axles.

Increases in power above this level in the future will require use of six axles with corresponding adhesion improvement. Six-axle locomotives of 4200 horsepower have been evaluated since 1970 and power ratings of up to 4500 horsepower are being developed.

Electric Locomotives

The diesel-electric locomotive is admirably suited to the practice of pulling long freight trains sized to permit the diesel-electric consist to negotiate the ruling grade at the maximum current permissible in the traction motors, and, hence, at high tractive effort and low speed. The electric locomotive, not limited in power by an on-board prime mover, is capable of developing higher power at high speed than the diesel-electric locomotive. Both types of locomotives are subject to the same physical laws governing maximum adhesion and resulting tractive effort assuming that equivalent control systems are employed; therefore, it is in the area of high-speed operations of freight trains that the electric locomotive has a special advantage. If this characteristic is to be exploited by United States railroads in the future, major changes must be made which involve the size of the crew, the condition of the track, and the capability of the simple three-piece freight truck to run at high speed.

In the past (Figure 13), with energy from diesel fuel significantly lower in cost than electrical energy, electrification was not economically justifiable. However, the escalation of petroleum fuel cost in the past three years has caused several United States railroads and the Federal Government to initiate studies of the economic potential of electrification of high density freight routes.

The extremely high fixed investment in catenary, substations, signaling and telecommunications modifications, and new motive power, required to electrify a railroad, is a major impediment to the adoption of this form of traction. North American railroads are capital intensive operations which, in recent years, returned on the average no more than 3 percent on investment. Consequently, their ability to raise the enormous capital required for electrification is a major obstacle. The uncertainty of the relative future costs of diesel fuel and electricity is a major unknown facing railroad managements upon which the economic success or failure of electrification depends. Railroad managements are understandably reticent to make the long-term commitment to electrification in the face of such imponderables.

Some of the claims advanced by proponents of the electrification high density freight routes include:

1. Reduction in the use of petroleum fuels.
2. Improvement in quality of freight service.
3. Lower maintenance costs.
4. Improved locomotive life.
5. Reduced emissions.

It is extremely important to put these claims in the proper perspective.

Fuel Savings

The ability of an electrified system to use coal or nuclear-based energy sources is obvious, but the magnitude of the savings in petroleum relative of total transportation usage is not always perceived. Based on the petroleum fuels used in railroad freight operations in 1975 of 3.3 billion gallons, the electrification of 10 percent (20,000 miles) of high density routes, carrying 50 percent of the current rail traffic, would save 1.65 billion (Figure 14) gallons of fuel per year. This saving is equivalent to 107,600 barrels per day, a saving of .6 percent.

For comparison purposes, two other possibilities are suggested for equivalent petroleum savings. The first is to transfer 40 percent of the current freight (220,000 x 10^6 ton miles) carried by the intercity highway trucks to the rail mode. The second is to convert 7.5 percent of existing oil-burning steam generating stations (which generate 292 x 10^9 kW-hr/yr and consume 8.5 percent of the total petroleum usage) to coal. Each of these alternatives may involve less capital outlay than railroad electrification.

Improvement in Service

Electric locomotives with their high power capability per unit can improve the quality of freight service. The penalty, however, is an increase in the energy required. Computer simulations of freight trains hauled by six-axle locomotives between Chicago and Kansas City indicate that an increase in average speed from 40 to 50 miles per hour (25 percent) requires a 20 percent increase in energy (Figure 15).

Maintenance Costs

Accurate prediction of maintenance costs for the electric locomotive awaits the result of more experience in applications of new model electric locomotives in the United States. Estimates of relative maintenance costs of electric and diesel-electric locomotives, based on locomotives with comparable tractive effort capabilities, are shown in the following table:

Maintenance Costs as Percent of Total Diesel Locomotive Maintenance

	Diesel Electric %	Electric %
Engine (including lubricants)	39	0
Electrical controls, traction motors, and other electrical components	14	17
Carbody, air brakes, equipment, safety inspections, trucks, and so forth	47	47
	100	64

It is expected that electric locomotive maintenance costs on a tractive effort comparison basis will be 60 to 65 percent of a diesel-electric locomotive. If locomotives were compared on the basis of horsepower capabilities, the electric locomotive relative maintenance costs would be further reduced.

There are other costs which need to be considered, such as scheduled fueling for the diesel-electric and catenary maintenance, and inspections for the electric locomotive. In some areas of the United States, catenary icing could be a serious potential problem, and heating of the catenary using circulating current may be a necessity and, possibly, some means of mechanically removing ice may be required under severe icing conditions.

Locomotive Life

It has frequently been stated that the diesel-electric locomotive, in contrast to electric locomotives, has a life of 15 years. While the allowable tax depreciation life of the diesel locomotive can be taken as short as 11 years, the actual useful operating life can exceed 25 years, although technical obsolescence will dictate savings by replacing locomotives before this time to benefit from new improvements. Figure 16 shows the distribution by age category of 17,911 locomotives built by General Motors Corporation and in service as of January, 1976. Twenty-two percent of this fleet is in the 20 to 24 year age bracket and 10.4 percent are over 25 years old. The average age is 13.7 years.

Environmental Considerations

Presently, diesel locomotives are considered a very minor source of pollution in the United States. They do have the inherent advantage of not concentrating emissions in a limited area, often close to population centers, as may be the case with central electrical generating stations.

The estimated emissions of diesel-electric locomotives as compared to comparable emissions from coal-burning steam generating plants supplying electric locomotives handling the same traffic in gross ton miles is shown in Figure 17.

These figures have been developed from the following data and references:

1. Coal having 1 percent sulphur and LHV of 10,550 Btu/lb.
2. Diesel fuel oil having 0.4 percent sulphur.
3. National average steam generating station heat rate of 10,478 Btu/kW-hr.
4. Total transmission losses – 5 percent distribution and 1.5 percent catenary.
5. Equivalent diesel-electric and electric locomotive transmission efficiencies.
6. Pollution emission of 3000 horsepower diesel-electric locomotive.
7. Pollution emission factors for coal-burning steam generating plants.

Whereas electrification does provide some reductions in NO_x, HC, and CO emissions, these are more than offset by SO_2 emissions, which many experts consider as a greater health hazard. There are other factors to consider when weighing environmental factors, but suffice it to say at this time, there are no statistics presently available to indicate marked advantages of electrification for environmental considerations.

Despite the enormous capital expenditure required for electrification of the railroads, minor savings of fuel possible, the mixed results of possible reductions in emissions, there may be justification in the future, dependent largely on relative energy cost, to electrify certain high-density routes. If this decision is taken, Electro-Motive will be ready to supply the most modern types of electric locomotives to the railroad operators. Currently, the GM-6-C (Figure 18), 6000 diesel equivalent horsepower locomotive, is in revenue service on ConRail between Harrisburg and Newark and a second locomotive, the 10,000 diesel equivalent horsepower GM-10-B (Figure 19), is undergoing extensive testing on ConRail.

Both of these units were designed and built by Electro-Motive in conjunction with ASEA to demonstrate to the United States railroads that General Motors is a viable manufacturer of electric locomotives and stands ready to supply electric motive power if and when it is required.

Summary

Some of the factors which make rail freight transportation an attractive contender for future expansion in the United States have been identified. There are no transportation developments on the horizon to seriously challenge the railroads as the most efficient means of handling intercity freight in the next 25 years. The basic railroad advantages in energy usage will become an increasingly important factor in the years to come.

The factors which have contributed to the development of the diesel-electric locomotive to its present position as the most efficient, reliable motive power system have been discussed with emphasis on the possible trends of future development. In addition, relative advantages of electric and diesel-electric locomotives have been presented and some of the claims for electric locomotives have been placed in proper perspective.

* * * * *

Question: In control of emission in diesel/electric versus fully electric locomotives, you neglect to mention that the SO_2 discharge can be rather easily controlled in a permanent fixed power plant. This cannot be done on a diesel/electric. Doesn't this fact indicate that electric locomotives using fixed power generation plants are better overall when comparing air pollution characteristic?

Answer: The control of emissions of the oxides of sulphur from coal-burning power-generating plants can be accomplished using various stack treatment processes. Each of these processes poses economic problems resulting from short life of the equipment and disposal of the large quantities of sludge produced. The demand for .5 percent sulphur coal from western sources with its attendant high transportation costs in place of higher sulphur coal from local sources attests to the current difficulty of SO_2 removal. In view of the major difficulties involved in stack gas pollutant emission control in fixed power stations there appears to be no clear advantage of electric locomotives over diesel electric locomotives in this area.

TABLE I
COMPARISON OF THE RATIO OF PAYLOAD TO TOTAL WEIGHT OF VARIOUS FREIGHT TRANSPORTATION MODES

	130 Ton Locomotive Plus 27-130 Ton Cars	130 Ton Locomotive Plus 50-70 Ton Cars	5-Ton Truck	20-Ton Truck	Coal Slurry Pipe Line
Gross Wt. – Tons	3,680	3,680	7.4	28	-
Net Cargo Wt. – Tons	2,700	2,200	5.0	20	-
Ratio of Net Frt./ Gross Wt.	.73	.60	.68	.71	.45-.55

TABLE II
ENERGY REQUIREMENTS, BTU/NET TON MILE

Aircraft	63,000	11,870 (Cargo jet)	42,000
Trucks	2,400	2,600 (40-ton truck)	2,800 (General) 1,900 (intercity) 7,000 (Local)
Pipelines	1,850 (All types)	261 (Large pipelines)	600 (Liquid only)
Railroads	670	250 (100-car frt. train)	330 (Unit train) 500 (Intercity) 700 (TOFC)
Waterways	500	633 (Inland barge)	500

TABLE III
DISTRIBUTION OF LOSSES IN A TYPICAL DIESEL-ELECTRIC LOCOMOTIVE AT 34 MPH

Rated Engine BHP	100%
Accessories, Cooling Fans, Blowers, Air Compressor and Auxiliary Generator	7.5
Main Generator Losses	3.8
Traction Motor Losses	5.3
Gearing Losses	0.8
Total Auxiliary Loads and Losses	17.4
Overall Efficiency (Engine to Rail)	82.6%

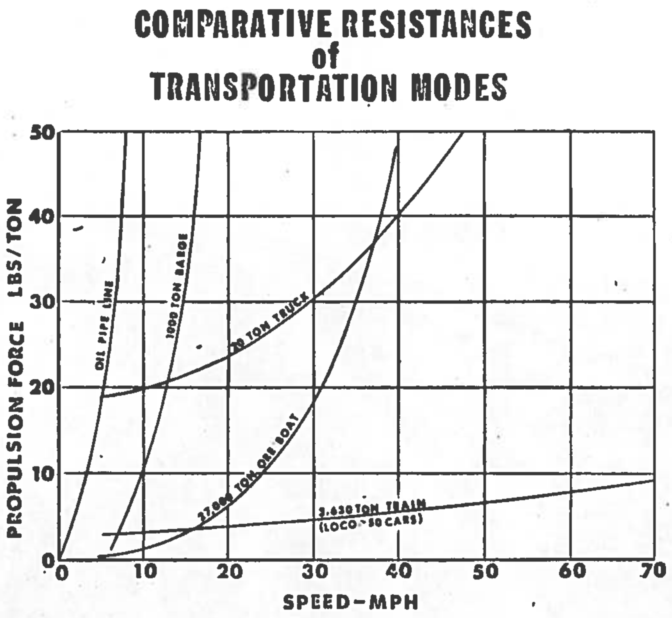
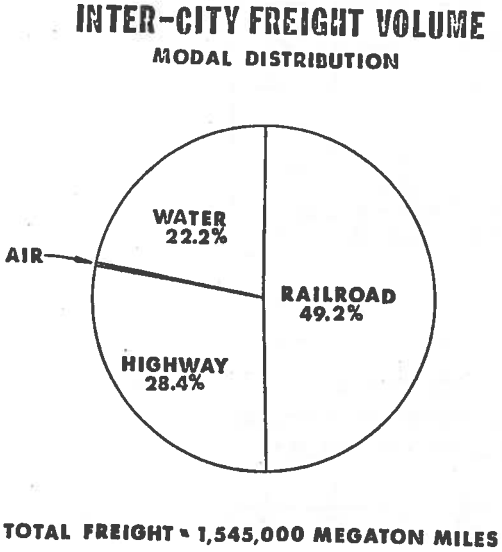
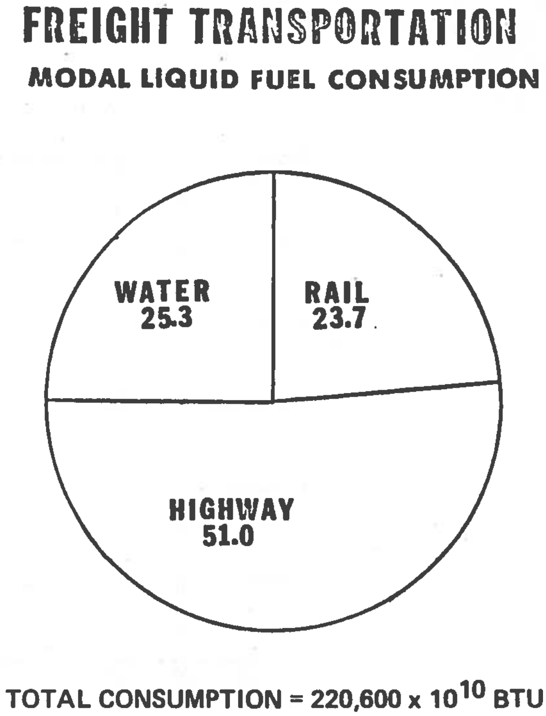


FIGURE 1



AAR YEARBOOK OF RAILROAD FACTS - 1976

FIGURE 2



DOT SUMMARY TRANSPORTATION STATISTICS - 1974

FIGURE 3

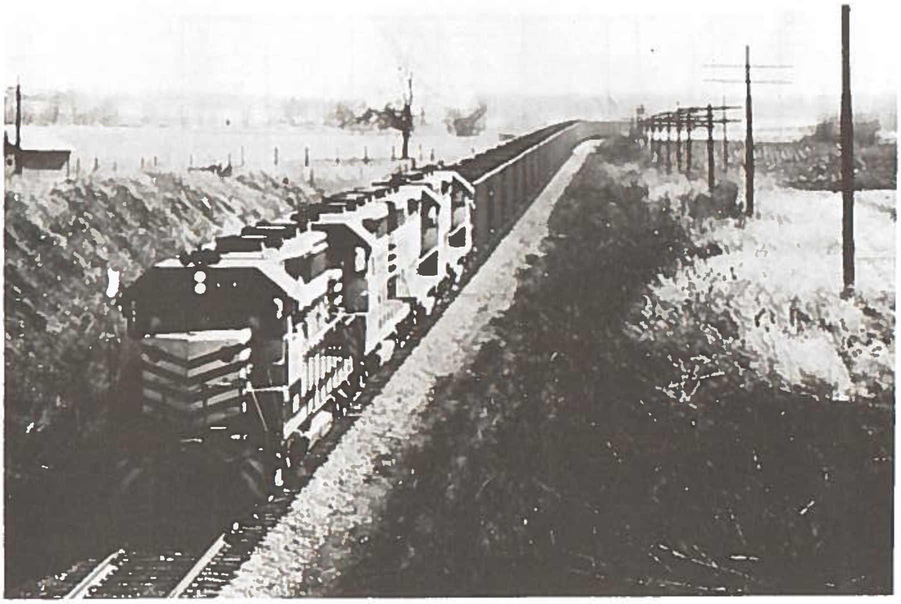


FIGURE 4
AMERICAN FREIGHT TRAIN

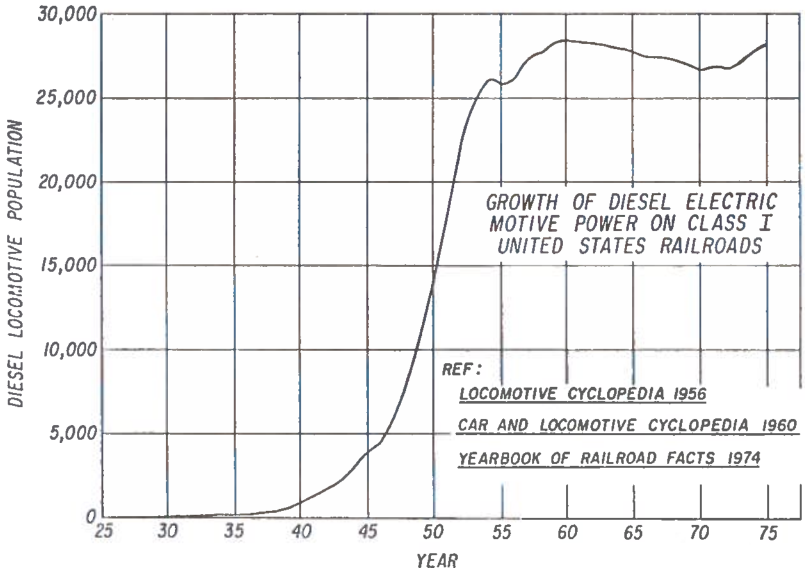


FIGURE 5

FIGURE 6
GENERAL PURPOSE, 2000 HORSEPOWER,
FOUR-AXLE DIESEL-ELECTRIC LOCOMOTIVE

FIGURE 7
GENERAL PURPOSE, 3000 HORSEPOWER,
FOUR-AXLE DIESEL-ELECTRIC LOCOMOTIVE

FIGURE 8
HEAVY-DUTY FREIGHT, 3000 HORSEPOWER, SIX-AXLE LOCOMOTIVE

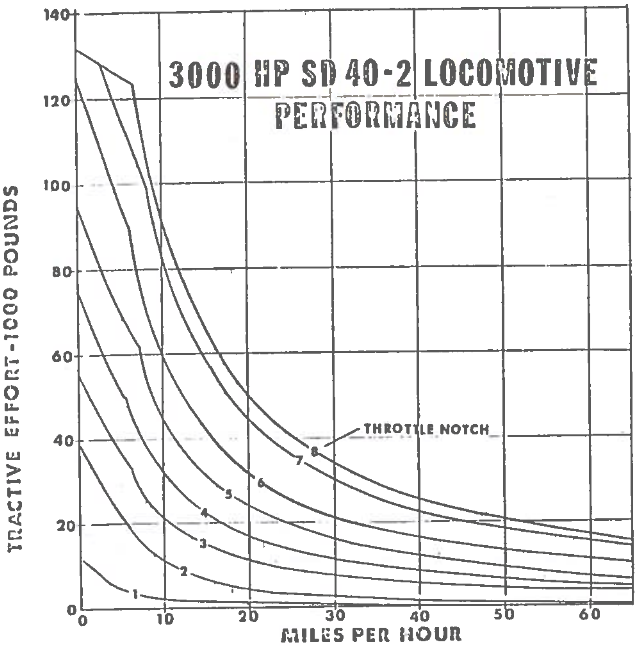


FIGURE 9

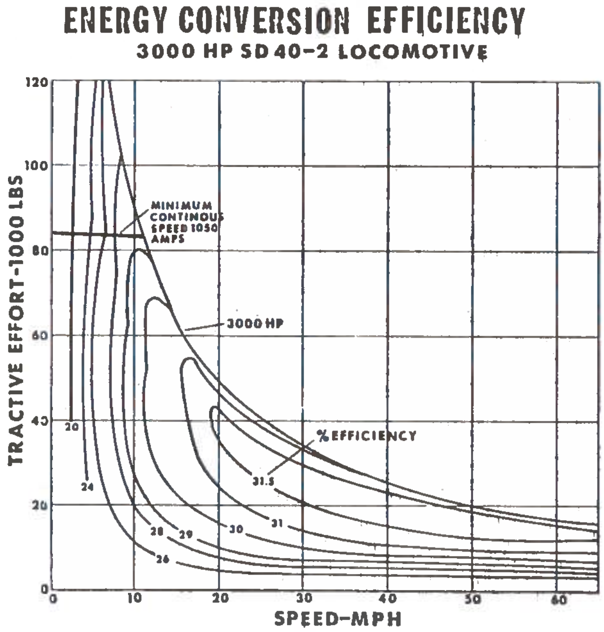


FIGURE 10

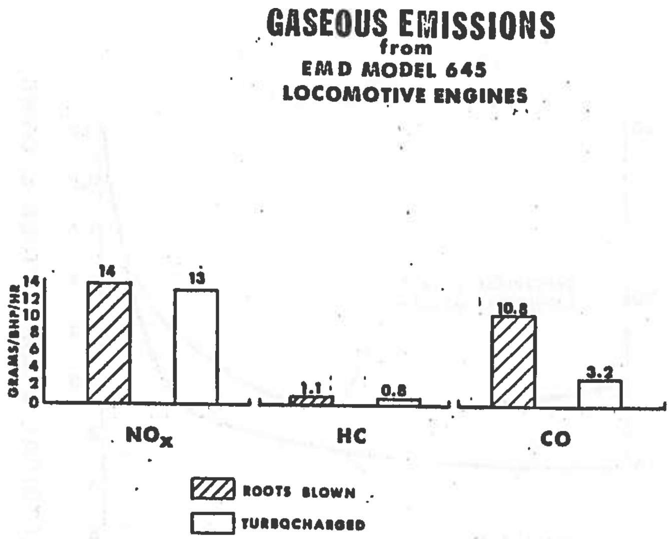


FIGURE 11

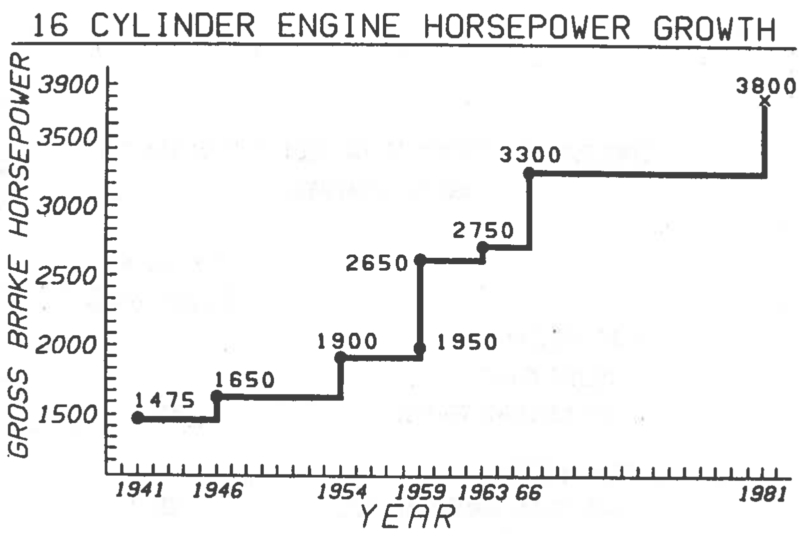


FIGURE 12

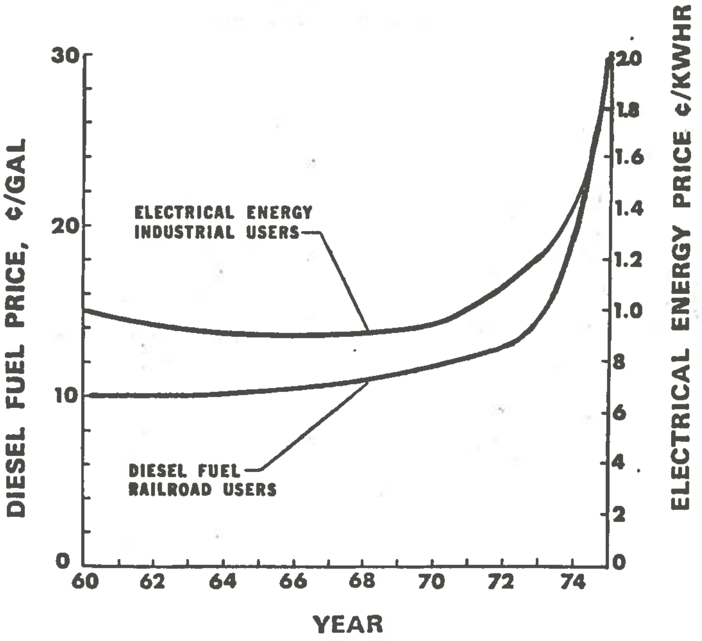


FIGURE 13

PETROLEUM FUEL SAVINGS BY RAILROAD ELECTRIFICATION AND ALTERNATIVES

	FUEL SAVINGS % TOTAL USAGE
- ELECTRIFICATION	
20,000 MILES	
50% RAILROAD TRAFFIC	.6%
- MODE TRANSFER	
40% TRUCK TRAFFIC TO RAIL	.6%
- ELECTRICAL GENERATING STATION CONVERSION	
7.5% EXISTING OIL BURNING TO COAL	.6%

FIGURE 14

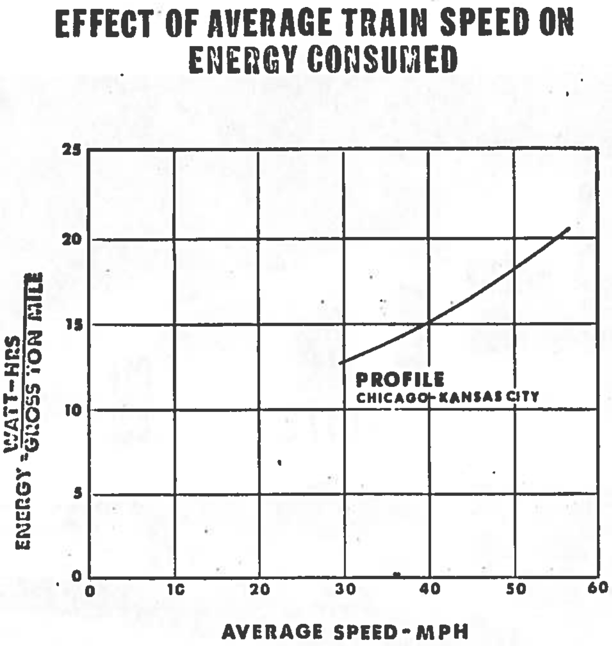


FIGURE 15

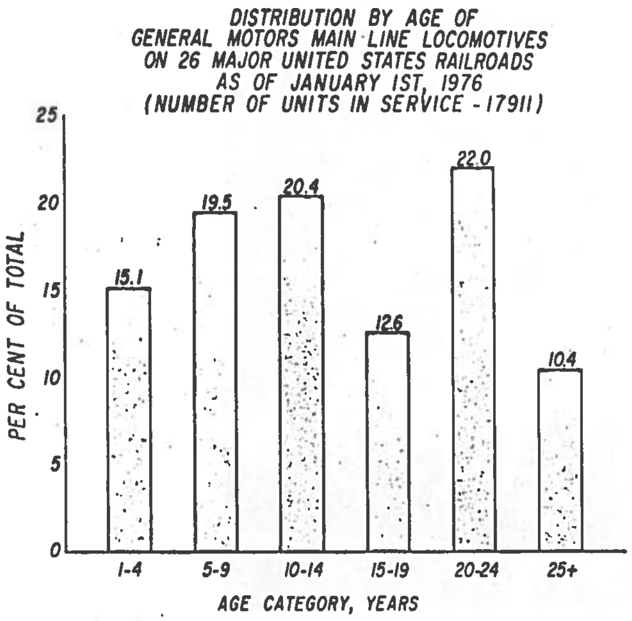


FIGURE 16

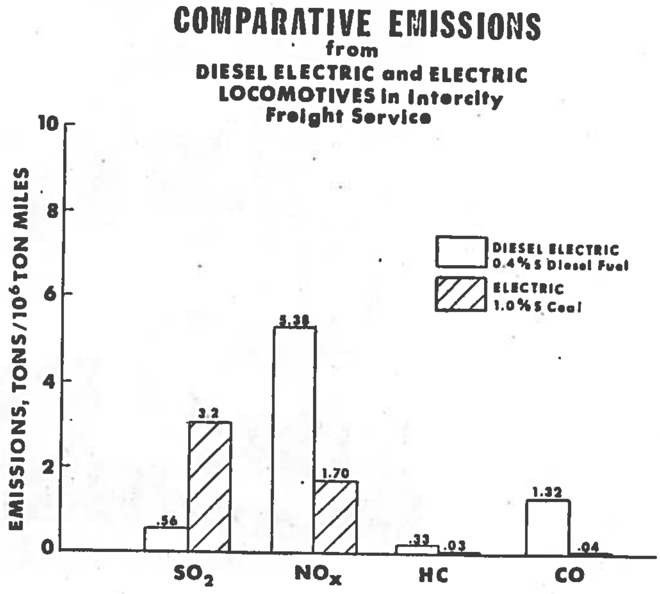


FIGURE 17

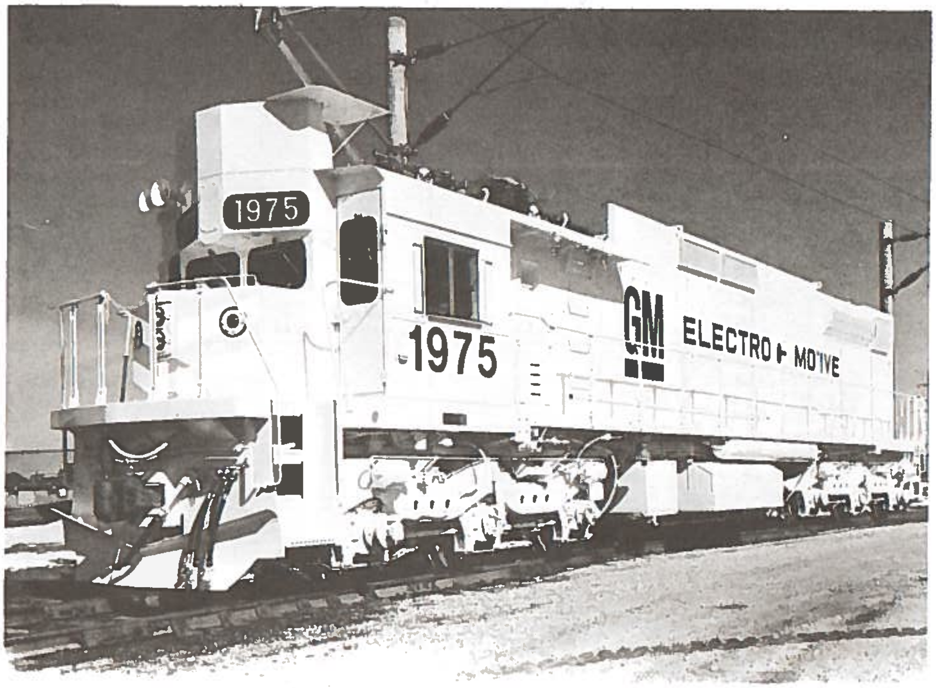


FIGURE 18
GM-6-C 6000 HORSEPOWER ELECTRIC LOCOMOTIVE

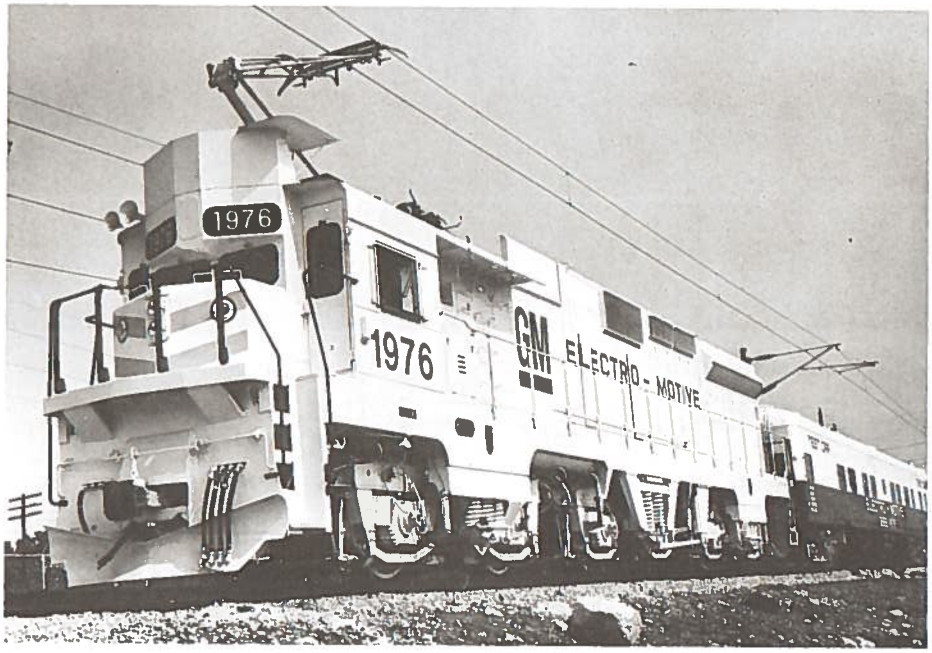


FIGURE 19
GM-10-B 10000 HORSEPOWER ELECTRIC LOCOMOTIVE

DISCUSSION PANEL

"FUTURE TECHNOLOGICAL DEVELOPMENT IN FREIGHT TRANSPORTATION"

Remarks by
F. N. Piasecki
President
Piasecki Aircraft Corporation

Why Vertical Lift Aircraft and Where Can We Use Them?

I think that I am at the wrong meeting. Last night I heard one of the biggest corporations speak, and the numbers used were so large that little businessmen had difficulty understanding. And today, Jerry [Ward] talked about the need to look on the long-range viewpoint, a way, way out. He said, "Don't look at the things like next Friday's payroll." Hell . . . I'm worried about THIS Friday's payroll!

Although we have landed men on the moon, it takes about the same amount of time to get a package from downtown Philadelphia to downtown New York as it did in 1912. That's when we built the tunnel under the Hudson River. Now I would say that is an imminent lack of progress in reducing intercity transportation time by surface means. We have built more nonstop highways, but the greater congestion and speed limits have not kept up with demand. The airplane, by concentrating on a more lucrative long-range aspect, has forced the enlargement of airports (I guess there's enough concrete in the average jet airport to make a short-haul highway). That coupled with the requirements of noise isolation has forced airports further and further out until you get to Dulles. Therefore, we have reduced the short-haul competitiveness of the air systems. I would conclude that there's been really no new competitive form of transportation, in basic surface transportation systems, for short-haul intercity operations since the bus.

By definition, the time to airports is going to get worse, and therefore we need new concepts in short-haul air systems. One way is to go directly from plant to plant, eliminating all the intermediate modes; another is a rapid air distribution system at the terminal ends of a long-haul system.

Now you can see the gap area in the middle between the jet air system and the surface systems. This gap in the short-haul area (using Jerry Ward's slide) is the same as the gap which exists between the truck lines to the airlines (all those dotted lines are mananas).

Now, true, Pete Bald said, "Yes, helicopters are fast but costly; they require a lot of maintenance; you can't really rely on them; they vibrate and they are noisy; and so it doesn't even look like they are part of the picture." And yet we HAVE HAD a helicopter short-haul air cargo system that was developed automatically, by necessity, because there were no passable road systems available – that was in Vietnam. What that did can be seen here at the end of the conflict figures where the helicopter was carrying 61 percent of the Vietnam transport.

Now, today's capacity of the helicopter is limited to 10 tons commercially; 16 tons are coming (the Sikorsky 3-turbine CH-53E is already flying); and 30 tons may be coming in helicopters if the Army is successful in re-establishing the HLH project. But there are some other things besides capacity, namely landing sites. You can't really land helicopters just anywhere. (Well you can, but you have neighbors who scream about it.) We have 17 in Philadelphia, and, incidentally, most of them are privately owned. Banks have them, hospitals have them, and various oil refineries have them for the helicopter burn center service in Chester, Pennsylvania. If you look at the limitations of not having heliports, landing requirements can be somewhat alleviated by lifting loads up by a hoist and not landing at the site [see Figure 1]. The Boeing Vertol HLH has been proposing this approach and is actually built, but not yet flown.

There's another view of it in construction operations [see Figure 2]. You can use existing railroad stations, yards, docks, power plants, parking areas, roofs, airports to lift cargo vertically without landing. So, we are pretty much limited by the problems of cost and lift capacity. Looking down to the very left-hand bottom of the curve [see Figure 3], you can see that the first line is helicopter useful load capacity versus gross weight. We have flown up to 16-ton payload size and the Russians have helicopters of 35-ton payload capacity, the limit of today's helicopters.

Now we are studying means of extending this. First of all, we've shown the ability of putting two or more helicopters together in a mechanically connected system. That's the next little line you see going up to the 50-ton payload category and could even be increased a bit more.

Finally, that same concept mixed with a static lift system, with sufficient helium, you get to the point where all the machinery weighs

---

Mr. Piasecki founded Piasecki Helicopter Corporation (the forerunner of Piasecki Aircraft) a quarter of a century ago. Widely recognized as an aviation authority, he holds several honorary degrees and is an active honorary member of numerous aviation societies.

nothing. In this way, the total dynamic lift is available entirely for useful load.

This approach increases capacity without any upper limit. You say, "Yes, but what about the cost?" Well, strangely enough, the static lift is but a fraction of the dynamic lift's cost. Up in the left top side [see Figure 4] you see the acquisition cost per useful load, and you see, as helicopters have grown in size, they are somehow going pretty vertical besides lifting vertical. And if you mix the same helicopters, say the CH-54B, with static lift, you lower the cost down to the horizontal lines, so that you have a substantial decrease in cost as well as a substantial increase in capacity.

The concept of mixing dynamic lift with static lift is shown here with four CH-54's and a 2 1/2 million cubic foot envelope, the payload lift being 75 tons.

In addition, the four points of suspension give you a controllability that is far in excess of past modes of lighter-than-air control. The problem in the old days was that the blimps, zeppelins, were like a sail boat that couldn't take the sails down.

Five hundred and fifty tons is the capacity of a French design similar to the Heli-Stat for lifting nuclear power plant components. We have concentrated on the small capacity unit because we think that's where the market is going to start. We show here the use of four in-production helicopters – the Bell 212 with a 1 1/2 million cubic foot envelope. This is a three-view, and the next slide shows the relative weights. The column of one-engine-out payload is very important because it shows the capability of this system to provide a much higher level of safety in the carrying of suspended loads than required by the present FAA requirements. Balance is maintained by the diagonally opposite helicopter to the engine-out helicopter reducing its thrust so that the two machines are balanced laterally and longitudinally, and the other two increase their thrust to provide the total lift required. That machine can lift 20 tons of payload with one-engine-out in hover and still have a 100 foot per minute rate of climb vertically.

The next slide [see Figure 5] shows the performance characteristics. It's not a high-speed machine, as you can see.

The next slide [see Figure 6] shows range versus payload. It can be ferried 1,600 miles. But that's not important because this is a short-haul system. But even in ferry operations that's not important because this is a vertical lift system, and if you have some fuel at the stern end of a ship, this machine can fly over and pick up that fuel without need of stopping the ship or the Heli-Stat. It's also good for altitudes up to 12,000 feet. It could be made higher but this is for transmission tower placement over mountains up to 11,000 feet.

Now, as to operating costs, you can see that compared to the largest helicopter, it is less than half of the operating cost per hour. The $1,500 per flight hour total cost includes amortization. Yet it carries over twice the payload.

Now, where will we use these? This is a military equipment table of everything above 16 tons [see Figure 7]; everything above this line cannot be moved by air vertically today. So there's a lot of opportunities including lifting a main battle tank weighing 60 tons [see Figure 8].

Commercially, there are many areas of application. The major point is that you can carry a load from your manufacturing site directly to the point of application. You can build your transmission towers in a nice factory with all the equipment and tools and standard working conditions and pay, and then carry the entire assembly and put it into its position. You say, "Maybe that place is several thousand miles away and this is not a very good system for long range." Then you'll have to have intermodal transport. This machine, with its external slung cargo, is good for short haul. You can put the loads on a ship or a barge, take it to the long distance, and then the Heli-Stat can take it off and put it into position. All other applications have been examined specifically. Large transmission towers are erected by helicopter now by bringing up sections at a time and erecting them at altitude, whereas the whole weight of the tower of 35 tons could be carried into position in one piece by the Heli-Stat and similarly in oil derricks.

In conclusion, this increase in capacity of vertical lift opens a wide application of vertical lift systems. Containers weighing up to 35 tons can be moved for the first time by a vertical lift system like this even while the ship is under way. The ability to save manufacturing costs, manufacturing time, and intermodal transportation costs and time in surface transport systems will cause an increase in the total transport system capacity for the future.

I think the DOT has a fertile area of technological development for transportation when they look into the vertical lift area. This is just but a few of the various sizes of systems we have looked at, and the slides just give an idea of the future configurations and new concepts. Therefore, I think DOT entrance into the vertical air lift field is necessary to identify where vertical air lift can add to the overall transportation service and where vertical air lift can become a catalytic link toward improvement in multiple mode transportation systems.

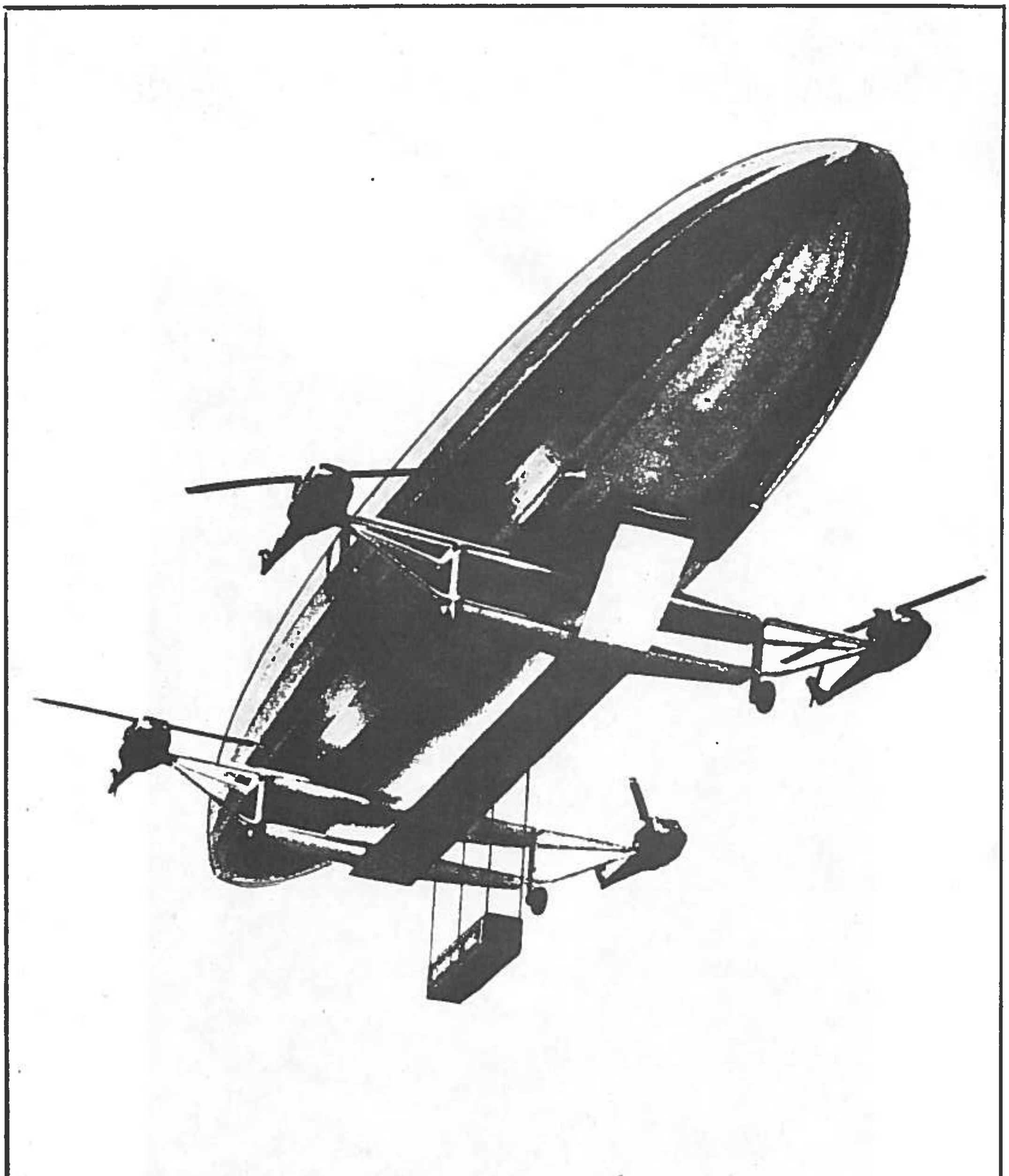


FIGURE 1
MODEL OF 97-212B PIASECKI HELI-STAT AIRCRAFT
LIFTING 8' x 8' x 40' CONTAINER

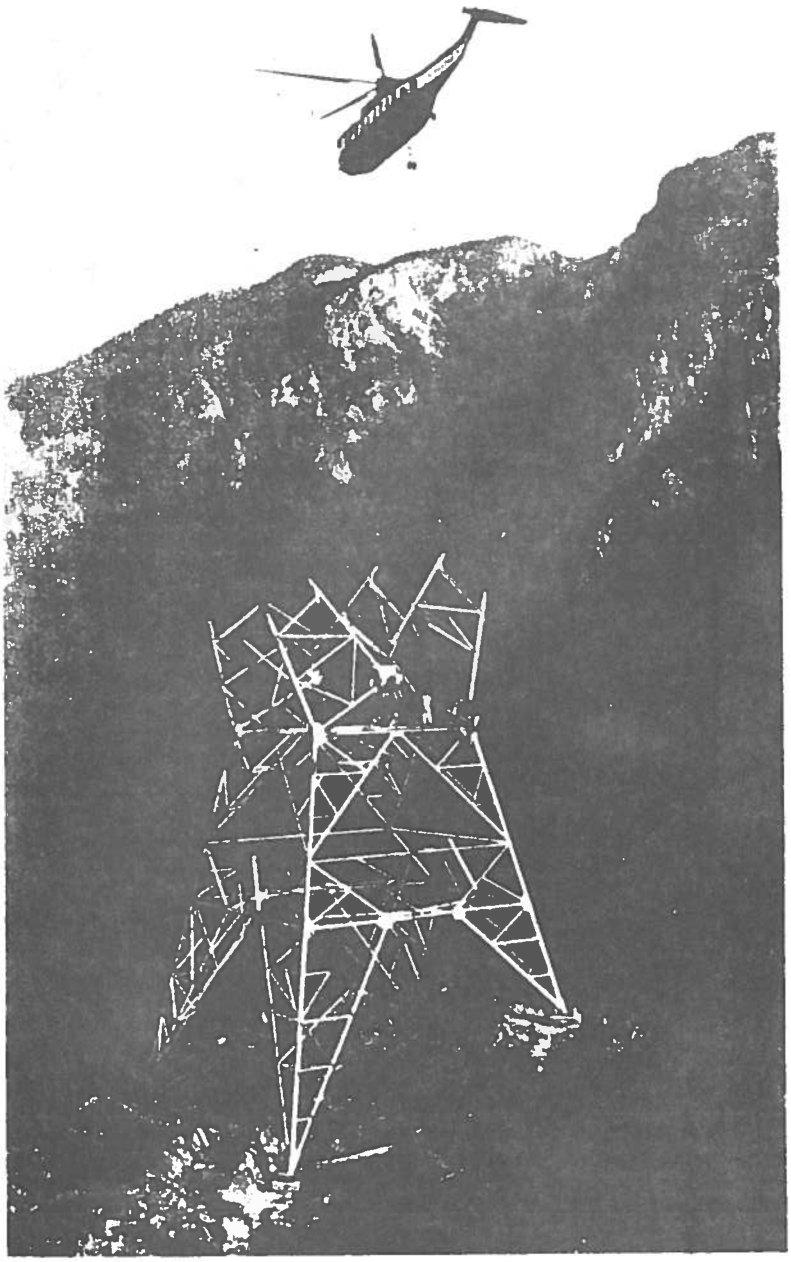


FIGURE 2
HELICOPTER USED IN ERECTING TRANS. ISSION LINE TOWER

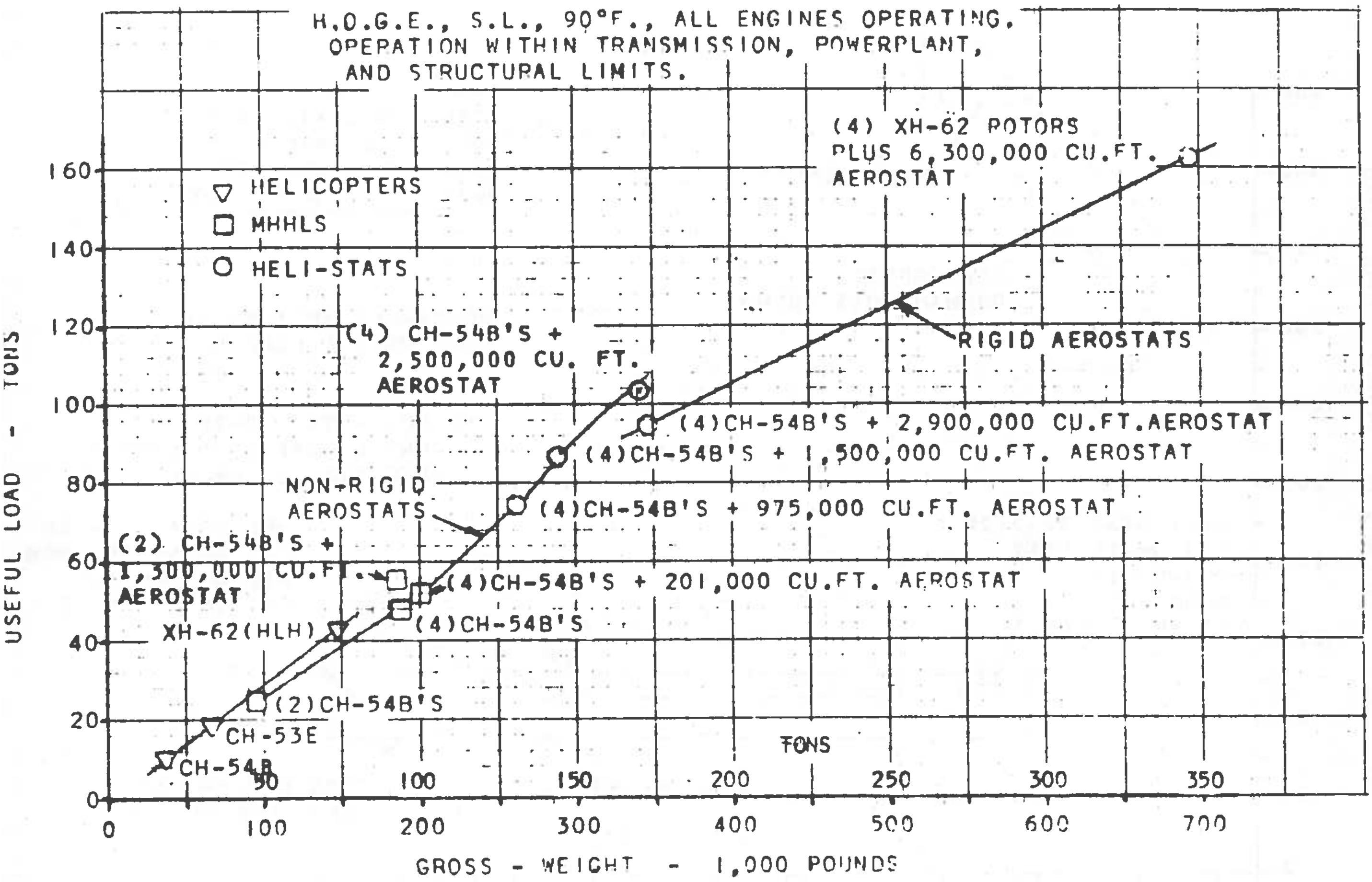


FIGURE 3
USEFUL LOAD VS. GROSS WEIGHT

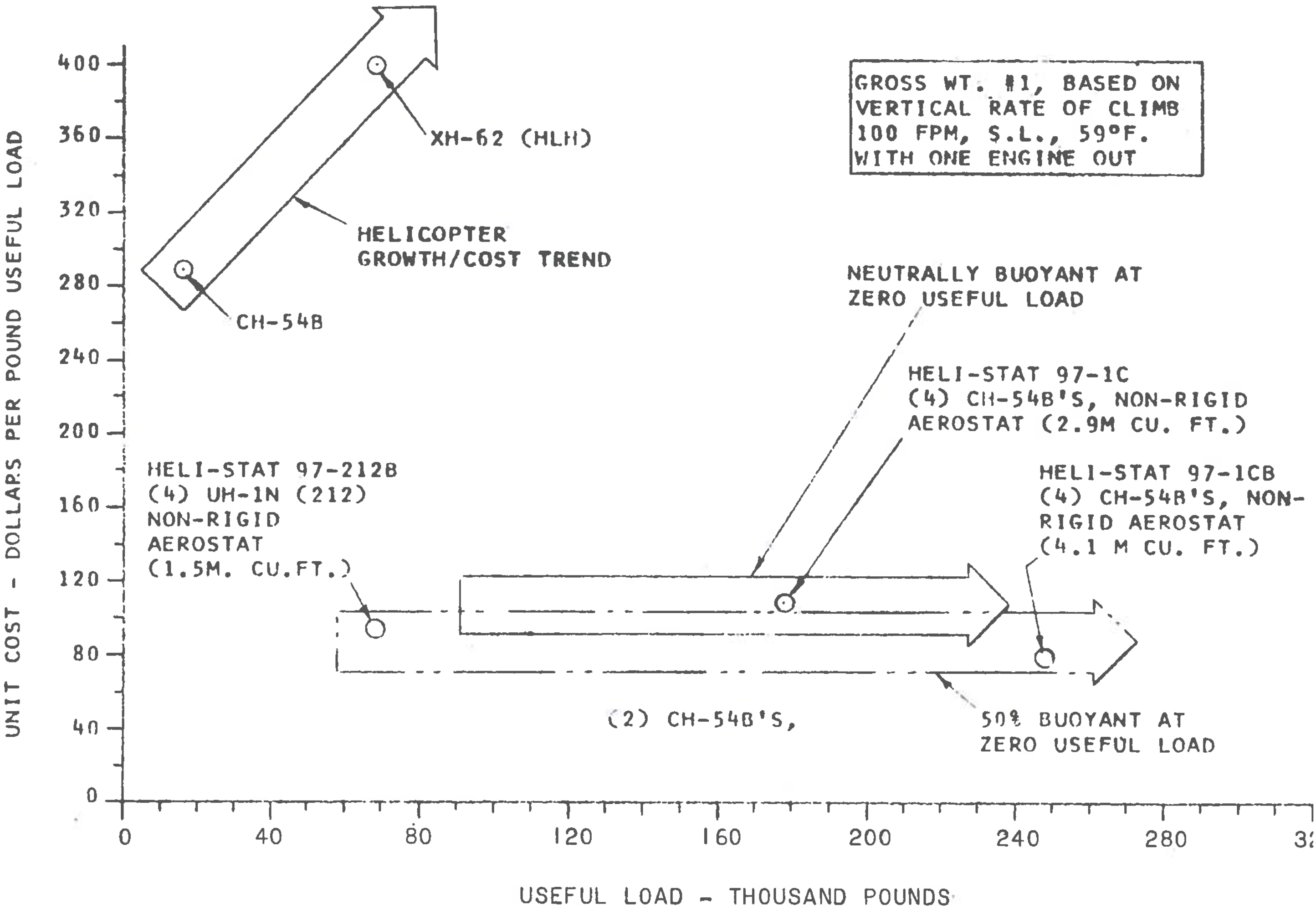


FIGURE 4
RELATIVE COST PER POUND OF USEFUL LOAD OF HEAVY-LIFT
SYSTEMS WITH ONE-ENGINE-OUT CRITERIA

HELI-STAT 97-58T

ALL ENGINES OPERATING, G.W. #2

3.3 PERFORMANCE SUMMARY, STANDARD ATMOSPHERE (S.L., 59° F.)

	UNITS	MODEL 97-58T
V MAX	KT.	80
CRUISE SPEED	KT.	60 (3)
LANDING AND TAKE-OFF SPEED	KT.	0
CLIMB, VERTICAL	FPM	500 (4)
CLIMB, FWD. FLIGHT	FPM	1,500 (1)
RANGE (NON-REFUELING AT 60 KTS.)	ST. MI.	175 (2)
FERRY RANGE (NON-REFUELING)	ST. MI.	1,580
HOVER CEILING (AEROSTAT PRESS. ALT.)	FT.	12,000

(1) LIMITED BY ASSUMED AIR-PRESSURE EQUALIZATION RATE OF 100,000 CU. FT./MIN. CAN BE HIGHER FOR SHORT VERTICAL DISTANCES.

(2) BASED ON S-58T EXISTING TANKS (292 GALS.) RANGE CAN BE EXTENDED BY TRADING PAYLOAD FOR FUEL.
150 GAL. INTERNAL AUXILIARY TANKS AVAILABLE PER HELI.

(3) CRUISE SPEED FOR BEST RANGE: IN HEAVY CONDITION 2 AUXILIARY THRUSTERS OF ONE PT-6/8.5' DIAMETER-PROP EACH CAN BE SHUT DOWN. IN LIGHT CONDITION ONE PT-6 IN EACH HELICOPTER CAN BE SHUT DOWN.

(4) S-58T TRANSMISSION LIMIT.

FIGURE 5

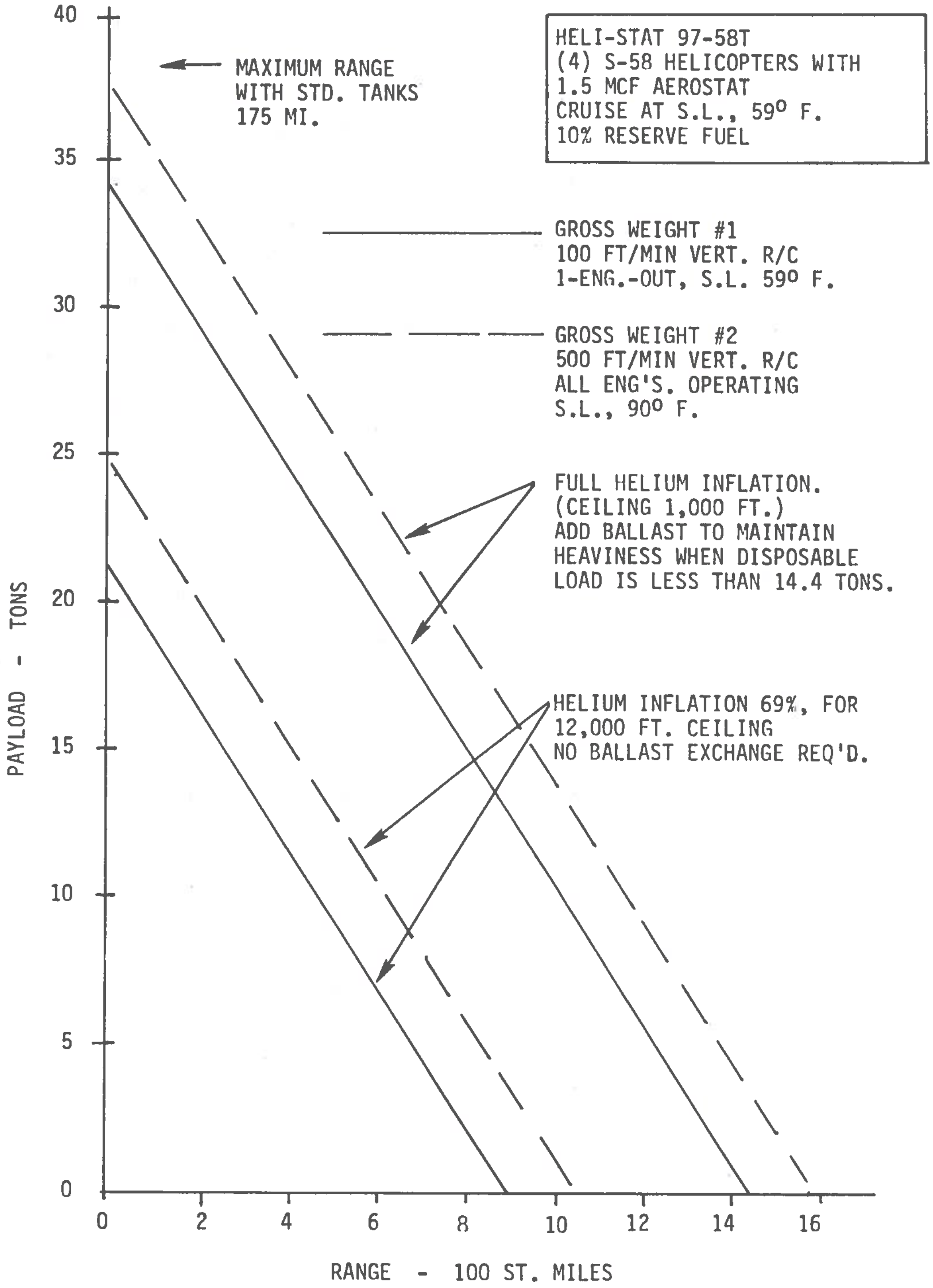


FIGURE 6
PAYLOAD VS. RANGE, 97-58T HELI-STAT

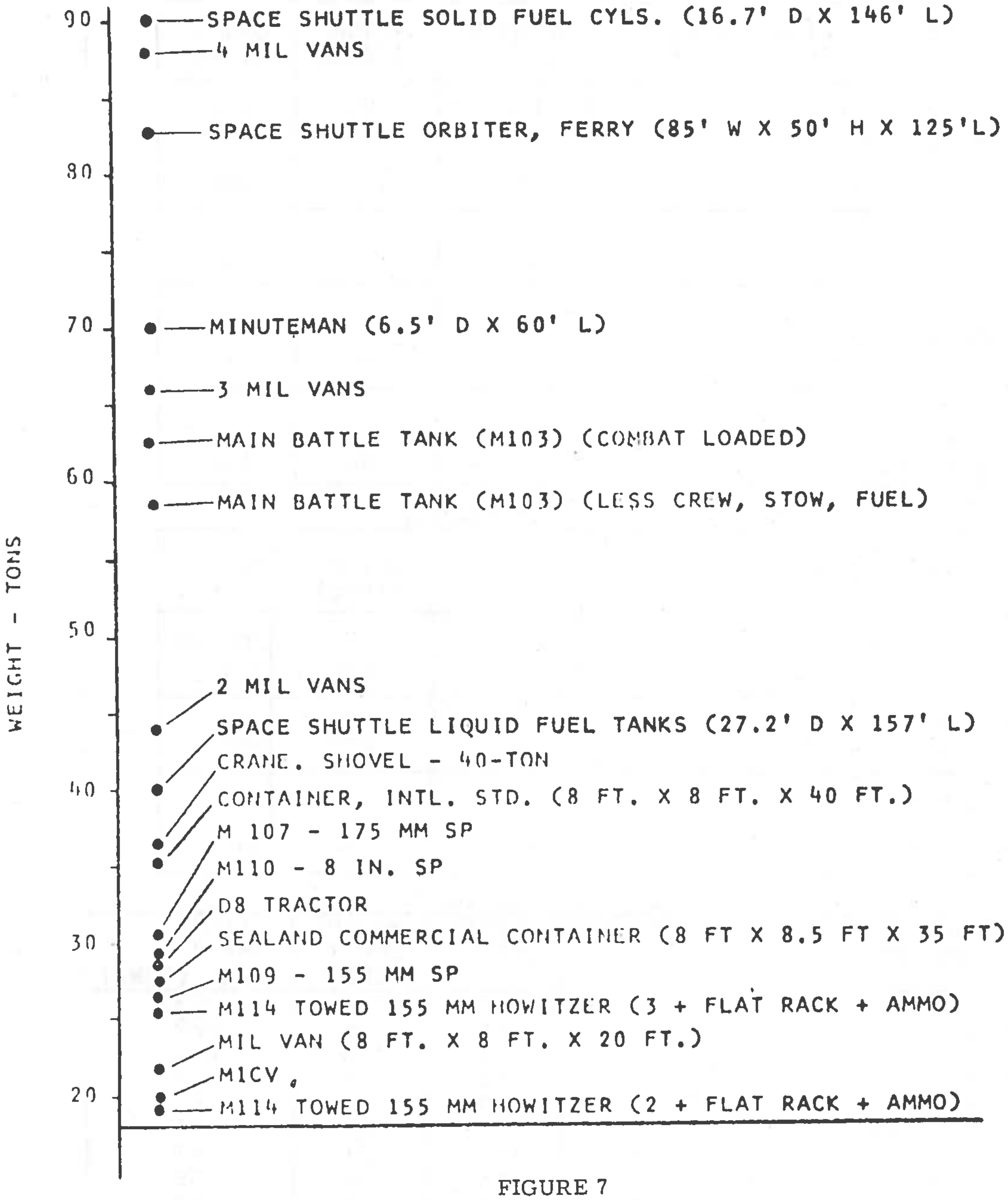


FIGURE 7
ITEMS OF MILITARY CARGO BEYOND LIFT CAPABILITY
OF CURRENT HELICOPTERS

LARGE MISSILE COMPONENTS

TYPE	WIDTH (FT.)	HEIGHT (FT.)	LENGTH (FT.)	WEIGHT (TONS)	DIST. S. MI.
MINUTEMAN	6.5 DIA.	6.5	60	70	3000
ORBITER LAUNCH	85	50	125	120	300
ORBITER FERRY	85	50	125	82.5	15
EXTERNAL TANK, EMPTY (S.S.)	27.16	DIA.	156.6	40	10
SOLID ROCKET CYLINDERS	16.65	DIA.	146	90	150

LARGE POWERPLANT COMPONENTS

TYPE	WIDTH (FT.)	HEIGHT (FT.)	LENGTH (FT.)	WEIGHT (TONS)	DIST. S. MI.
UNLIMITED	22	22	67	820	200 TO 390
MINIMUM JOINTS	22	22	30	550 TO 270	390
MINIMUM SIZE SECTIONS	3	20	30	50	390

IMMOBILIZED AIRLINERS

AIRLINE TRANSPORT	WIDTH (FT.)	HEIGHT (FT.)	LENGTH (FT.)	WEIGHT EMPTY TONS	WEIGHT EMPTY + FUEL (TONS)
747 (E-4)	196	64	231	185	309
DC-10	161	58	181	115	222
L-1011	155	55	179	110	200
707 (VC-137)	146	43	153	69	121
727	108	34	153	48	67
737 (T-43)	93	37	100	31	41
P-3C	100	34	116	31	61
EC-130	133	38	98	38	69
C-9B	93	28	119	33	52

FIGURE 8
POTENTIAL CRITICAL SUPER LOADS FOR AIR LIFTING

DISCUSSION PANEL

"FUTURE TECHNOLOGICAL DEVELOPMENTS IN FREIGHT TRANSPORTATION"

Remarks by
Gary C. Watros
Office of Advanced Systems
Transportation Systems Center

TRAILS – A New Concept in Freight and Passenger Transport

Introduction

TRAILS is a concept which combines the best attributes of today's roadway and rail systems to move container freight and people in a fast and efficient manner. In so doing, it employs current vehicle, guideway, and terminal technologies in a new operational concept made feasible by advances in automation and techniques for management/control of large systems. Basically, TRAILS uses the roadway systems to feed an exclusive line-haul network on which automatically controlled vehicles operate at 120 mph.

As a concept, TRAILS is in its very early, fluid state and will no doubt change considerably as it receives closer scrutiny at the Center and elsewhere. The concept is being exposed at this time in the hope that comments from a wide audience and independent study of the basic idea will make it better and improve the chance that something like TRAILS will someday become a reality.

The Trails Service Regime – Today and the Future

Freight Movement

Only those goods generally thought as containerizable will be considered. This category accounts for nearly half the annual 2 trillion ton-miles, comprising the equivalent of 50 million 40' containers.[1] Of this potential container market, about 60 percent is shipped greater than 200 miles, the distance below which direct truck service is generally "unbeatable."

The extensive roadway network available to trucking makes it a natural choice for most pickup/delivery operations, short-haul up to about 200 miles and certain longer low-volume routes that could not be efficiently served by a multimodal network. The service regime, then, is most line-haul movements over 200 miles long (about 25 percent of total annual ton-miles).

Today's trucking is relatively fast and reliable and oriented to lower density goods compared to rail service. However, trucking suffers from being highly labor-intensive and from relying upon petroleum fuel which in time will become increasingly expensive. Moreover, a stiff penalty is incurred in the national cost of highway maintenance necessitated by trucking. Rail service is generally cheaper, and much slower, and experiences poor schedule reliability. Moreover, rail equipment is over-designed (too heavy) for the usual densities of container goods and its productivity is low due to inefficient operations and procedures.

The inherent advantages and disadvantages of current modes combined with future trends suggest a more appropriate course for the next century. Trucking should concentrate on those functions it is most appropriate for – pickup and delivery and very short-haul. Moreover, these short-range services are most suited to the adoption of non-petroleum power systems for trucks. Line-haul movement of container freight should be handled by a new system that is faster, more efficient, more reliable and less expensive than today. Current line-haul costs are unnecessarily high due to labor intensity (trucks), poor utilization of equipment (rail), and to a lesser extent, rising energy costs. Faster, more reliable service than even truck affords would reduce the opportunity costs of "idle" inventory in transit. It would also improve the potential for more centralized manufacturing and distribution (lower consumer prices) and would improve the quality of delivered perishables. All this suggests a need for national line-haul service that:

- Is mostly automated.
- Operates vehicles non-stop between origin and destination terminals with minimal empty backhauls.
- Employs light-weight container vehicles that are energy efficient.
- Uses electric propulsion.
- Is fast and reliable.
- Interfaces with trucking via efficient, automated container transfer terminals.

Prior to joining the Transportation Systems Center close to seven years ago, Mr. Watros was a member of the mission control center at NASA's Manned Spacecraft Center in Houston (now the Lyndon B. Johnson Space Center).

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[1] Reebie Associates, National Intermodal Network Feasibility Study, FRA/OPPD-76/2.1; May, 1976.

Intercity Travel

The arena of consideration is trips of greater than 200 miles and less than 750 miles. Currently, this regime includes about 40 percent of all intercity passenger-miles.

By far, the auto is the dominant mode primarily because it is inexpensive (in a marginal cost sense), easily accessible and affords true origin-destination service. However, it will probably become less desirable in the future because of restricted speeds, Interstate maintenance disruptions, increasing fuel costs, and decreasing car size and amenity levels.

Today, about one-tenth of all travel in this regime is by air. However, current service levels are much poorer than one would expect. A random sampling of service available between eastern cities 200-400 miles apart shows that the average airport-to-airport speed is about 110 mph and door-to-door speed is only 60 mph. Furthermore, short-haul air service is much less profitable for the airlines than long flights due to higher fuel and labor costs per passenger-mile. With fuel costs becoming even more critical, airlines may largely abandon this service regime in the future.

Patronage of today's bus and rail service is negligible (about 2 percent) primarily because it is slow and inconvenient.

In summary, today's public modes do not offer attractive alternatives to the automobile for most trips between 200 and 750 miles long. Moreover, auto travel itself will become considerably less enjoyable and affordable in the future. This situation, coupled with rapidly rising travel demand due principally to the advent of the four-day work week, creates a serious transport deficiency. A national service is needed, that bridges the gap between the good transportation afforded by the auto (up to 200 miles) and the air system (over 750 miles). That service should be readily accessible, frequent, and fast (100-150 mph).

Basic TRAILS Operation

Freight containers would be brought by truck from shipping docks to TRAILS terminals (240 total), designed for fast, largely automated transfer of these containers to waiting TRAIL cars. Each car is loaded with one (or more) containers destined for a single terminal. Once loaded, these self-powered cars would be automatically routed non-stop to the destination terminal where trucks would then deliver the containers.

Travelers would drive to the nearest passenger station (1240 total) where they would catch the next available TRAIL car on a "no reservation" basis. Express cars depart from major terminals (240) on each link an average of one per minute — local cars (serve all stops) would depart about every 15 minutes.

Terminals and Stations

Major terminals (40 total) are generally located near the junction of major Interstate routes and the "beltways" around large metropolitan areas. Areas such as NYC, LA, and Chicago would each have several major terminals — others just one. Minor terminals (200) serve the remaining SMSAs over 50,000 population. Terminals handle both container freight and passengers. Passenger access is also provided at an additional 1000 stations located adjacent to established links between terminals.

Guideway and ROW

The guideway is high-speed rail track, usually located in the median of the Interstate highway (see Figure 1). Interstate ROW was chosen because the alignment is in tune with current transportation demand patterns and roadway access is easy. Railroad ROW is generally inappropriate for use because conventional operations, which must be retained for heavy bulk transport, are incompatible with 120 mph operations on the same track. Abandoned rail ROW may be suitable in some cases, however. Acquisition of new ROW would be avoided, as cost and disruption make it politically unacceptable.

Two lanes require a ROW at least 30' wide — 45' or more is desirable to maximize visual separation between slow highway traffic and the speeding TRAIL cars. Double width is needed where terminals and passenger stations are situated to install sidings (two) for originating or terminating vehicles. The terminal itself may be located adjacent to the highway or perhaps elevated over it. In any event, these sidings would have to become elevated at some point to reach the terminal buildings and storage yards. The interstate medians are apparently wide enough to accommodate the TRAILS guideway along at least 90 percent of the present mileage outside metropolitan beltways. However, bridges usually lack a wide median, so the guideway may have to be elevated at these points. Underpasses for the most part have been designed to allow the construction of additional lanes and so could accommodate TRAILS without rebuilding. Interchanges between Interstates will require construction of elevated ramps if both routes are used by TRAILS. The maximum grades and curves of the Interstate are apparently safely negotiable by the 120 mph TRAILS vehicles.

Route Structure

The transport demand patterns for passengers and container freight are generally similar, with some exceptions. Patronage of TRAILS for travel over 750 miles should be low and so transcontinental links needed for freight would not see much passenger use. Likewise, recreational areas that could justify passenger service would not need much freight service. However, the synergistic effect when both demand patterns are considered simultaneously means one can justify a larger national network than if the system handled only one or the other. In this way, a nationwide route structure of perhaps 20,000 miles (50 percent of Interstate mileage) could be justified. Figure 2 depicts a typical TRAIL network.

Service

Freight

Service is limited to the handling of freight shipped in standard containers, 40' x 8' x 8' and subdivisions thereof. Terminal operations are geared to fast throughput of the large (40') containers since roughly 60 percent of containerizable freight would use this size alone. These containers would be moved directly from trucks to waiting TRAIL cars (shrouds removed) by automated equipment in a few minutes (see Figure 3). Smaller containers would be temporarily stored until a full carload could be made up for a given destination terminal. In no case, however, would a small container be held more than about 12 hours. It would leave on a less-than-full car for its destination or be sent to a nearer terminal for reshipment.

Pickup and delivery service between shipper/receiver and terminal would average a couple hours for container shipments inside the normal 50-mile capture radius of TRAIL terminals at either or both ends of the cargo trip. So, nearly all 40' containers would receive same-day or next-day delivery (dock-to-dock). Figure 4 compares TRAIL service with direct truck delivery. One- or two-day delivery of nearly all smaller shipments could be guaranteed.

Passenger

Express service would be available between all 240 terminals in the network. Automated passenger vehicles would depart from terminals on each link on an average of one per minute. The cars proceed automatically on a prescribed route, stopping only at terminals (not stations). Service to and from the additional, passenger-only stations is provided by "local" cars operateing between the terminals at an average frequency of every 15 minutes. Using express and local TRAIL cars, passengers would travel at an average speed (including stops and transfers) of about 100 mph between origin and destination.

The Vehicles

Both freight and passenger vehicles are similar in outside appearance, same dimensions, and share common suspension, chassis, propulsion and controls wherever practical. Conventional steel wheel/steel rail suspension is used and the chassis is a light-weight design. Propulsion is considered to be flywheel-electric in which the flywheel stores energy by being spun-up as the vehicle transverses short electrified sections of the guideway, spaced every 20 miles or so. That energy is used for electric-drive motors mounted front and rear.

The container car configuration is shown in Figure 5. Prior to loading, the vehicle is shroudless (a flat car) to facilitate loading the container(s). Once loaded, the shroud is dropped in place and latched, making the vehicle aerodynamically smooth and virtually pilferage-proof.

The trade-offs associated with system command and control design are most complex. For now, distributed control with "mindless" vehicles has been tentatively selected. Onboard systems do maintain given headways and can detect obstructions and automatically stop the vehicle. For routing and other functions, the TRAIL car transmits information to the local control system for the sector of the network it currently is in. This information would include vehicle identification, location (updated dead reckoning), speed, destination, systems status, and emergency voice communications (passenger car only). With this information on all vehicles within its sector, Local Control monitors and modulates vehicle flow, activates switches, rectifies some vehicle systems problems via RF commands, and dispatches assistance to disabled vehicles. Local Control also notifies Central (national) Control of guideway obstructions, disabled/stalled vehicles, inoperative switches and traffic levels. Central Control is responsible for overall vehicle scheduling and routing coordination throughout the system.

TRAILS Performance

Transport Speed and Range

Vehicle cruise speed of 120 mph was chosen as a reasonable compromise between the requirements of travelers and shippers. Both services should run at the same speed to minimize operational conflicts and maximize guideway capacity. This speed is deemed to be the low end of acceptable speeds for passenger service and the upper end of reasonable speeds to move high-value, low density freight. Also, above about 120 mph, TRAILS would consume more transport energy than today's roadway modes. Finally, speeds much above this are not compatible with the Interstate alignment.

In any event, 120 mph cruise speed means a system-wide average speed of about 110 mph for passengers and 120 mph for freight. This compares with average auto speeds of about 50 mph, buses 45 mph, trucks at 40 mph and rail service of five mph. This, combined with a high service frequency nearly equal to today's auto and truck operations, more than doubles the intercity ground transport range for the same time investment.

Same day freight delivery (10 A.M. to 4 P.M.) is extended from 200 miles by direct truck to nearly 400 miles, and next-day delivery is possible on the longest domestic hauls which require three to four days now by direct truck and up to three weeks by rail. This saves the "opportunity cost" of goods in transit (value times interest rate) and improves delivery reliability considerably.

Capacity

The addition of TRAILS lanes to the Interstate route structure greatly increases link capacity. Theoretically, vehicles could be operated at 10-second headways or less (current group-transit studies use three seconds). At 10-second spacings, one TRAIL lane provides the transport equivalent of three roadway lanes – at three seconds, 10 roadway lanes. TRAILS, therefore, would eliminate the need for and cost of widening the Interstate.

Energy Consumption

Figure 6 compares the energy consumption of the various TRAILS services with roadway systems. The inherent energy efficiency of TRAILS derives from three basic attributes: steel wheel/steel rail for low rolling resistance, the opportunity to streamline effectively, and constant speed operations with relatively few (or no) stops.

Comparisons show that passenger service (TRAIL-PAX) would consume about half as much energy at 120 mph than the auto does at less than half that speed. TRAILS would move freight (TRAIL-FREIGHT) three times faster for the same energy consumption as trucks.

Sizing the TRAIL Fleet

TRAIL-FREIGHT

Recent estimates for the current containerizable freight market are that it comprises the equivalent of 50 million 40' containers and that 60 percent of that is shipped more than 200 miles. Considering the future growth in such shipping and the fact that not all shipments would use TRAILS, it is not unreasonable to assume that the system could be handling 30,000,000 containers (40' equivalent) per year. Given the speed of the system, the turnaround efficiency of automated terminals, and the fact that the average shipment is about 500 miles, each TRAIL-car could handle roughly 300 loads/year. At this rate, 100,000 TRAIL-FREIGHT cars would be required.

TRAIL-PAX

Today, about 500 billion passenger-miles are traveled on trips between 200 and 750 miles long. Future growth (or at least demand) may be dramatic with the advent of the four-day work week. So, it is not unreasonable to assume that TRAIL-PAX could capture 300 billion pax-miles in the future, assuming fares were reasonable. To handle this with 16-hour service days and 65 percent load factor, a fleet of 20,000 TRAIL-PAX cars would be necessary.

System Costs

Capital Costs

Figure 7 shows the cost elements of the full system. If thinking in terms of many billions makes one uneasy, remember that this represents less of a national commitment than the interstate system was in the mid-50's. In terms of today's dollars, this cost estimate is comparable to the total cost of the Interstate, but represents a smaller percentage of the future GNP than did the Interstate in the past. Furthermore, this estimate is probably quite high. Also, by way of comparison, today's inventory of 1.7 million freight cars would cost $50 billion new, the national auto fleet $400 billion and the truck fleet over $100 billion.

Annual Costs and Revenues

Figure 8 shows the annual balance sheet. Revenues could be considerably higher since the freight rate assumed is about half that charged by intercity common carrier trucking and the passenger fare is only equal to today's bus and less than half air fare. On the other hand, cost estimates were biased toward the high side, especially for fleet replacement where only a 10-year vehicle life was assumed. Despite these conservative biases, the "bottom line" shows a profit, surprisingly. Upon reflection, this does seem possible for two major reasons. First, unlike past high-speed ground studies this system is designed to haul both passengers and freight. Dual use of the expensive guideway and command and control systems spreads these costs over a broader revenue base. The system would probably not be economically viable if only freight or passenger revenues were available. Secondly, this is a national network as contrasted to the corridor system studies of the past. By providing national service, market share is (or can be) greater than for the limited systems considered heretofore.

Summary

This proposal is certainly sketchy, leaves many questions unanswered, and has made assumptions that must be checked. However, it does say that it may really be possible to achieve a quantum improvement in intercity transportation on a pay-as-you-go basis. It does appear that TRAILS or something like it has the potential to stir the nation to a commitment of the magnitude of rural electrification, the Apollo project, and the Interstate system.

* * * * *

Question: Why have you not included vertical lift aircraft (200 mph helicopters) in your TRAILS versus other mode comparisons?

Answer: No direct comparisons have been made between TRAILS and other "new" systems, only with commonly used existing modes.

Question: As I understand the toy train in the lobby, the system would oblige passengers to change seats while the train is under way. Is that correct? Now, this suggests to me a rather hectic scene with commuters desperately pushing past each other in the opposing streams of humanity, carrying parcels, luggage and umbrellas, cursing and sweating. Would it really be like that?

Answer: . . . the train shuttle concept would require passengers to reseat themselves at least twice – upon joining the mainline train and prior to departure. However, I don't think it need be the hectic scene you envision.

First, the system, like Amtrak, would not carry commuters, thus avoiding the high demand peaks of that passenger market. Second, the vehicles would be designed with at least 40-inch-wide aisles to facilitate two-way foot traffic. Also, train length would be limited through system and reservation management to limit the distance a passenger must walk. Third, a minimum of five minutes would be made available for reseating by setting a minimum spacing between consecutive rendezvous (about 20 miles for a 120 mph system).

Through such measures, reseating can be made tolerable at least. However, baggage handling needs further investigation.

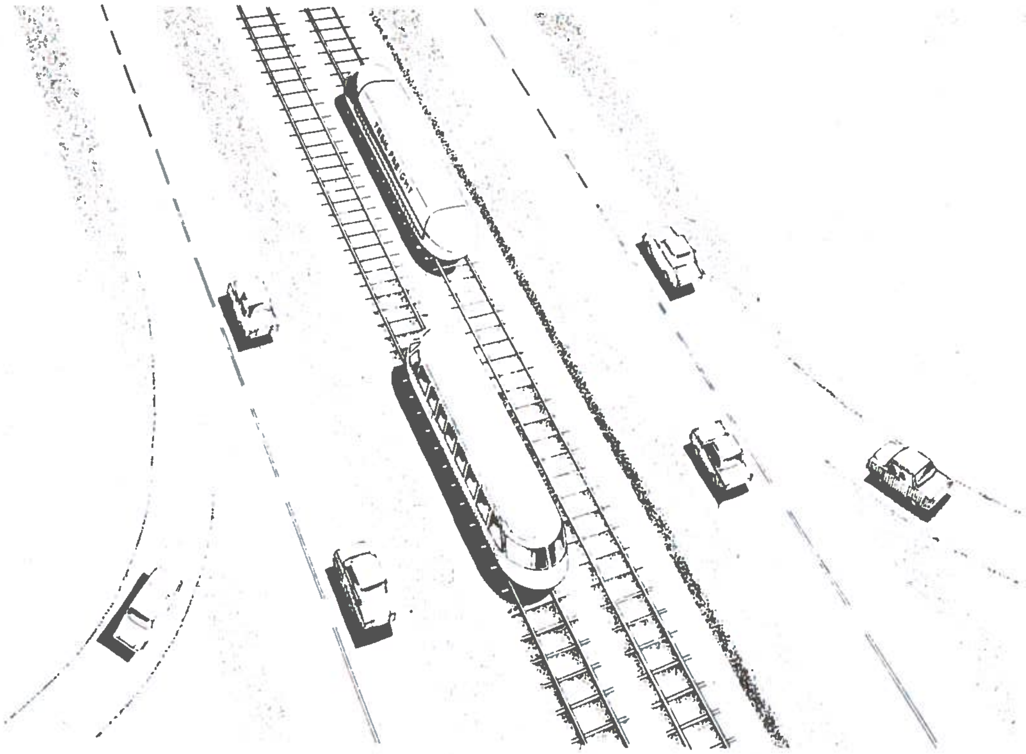


Figure 1. TRAILS – A "Birds Eye" View.

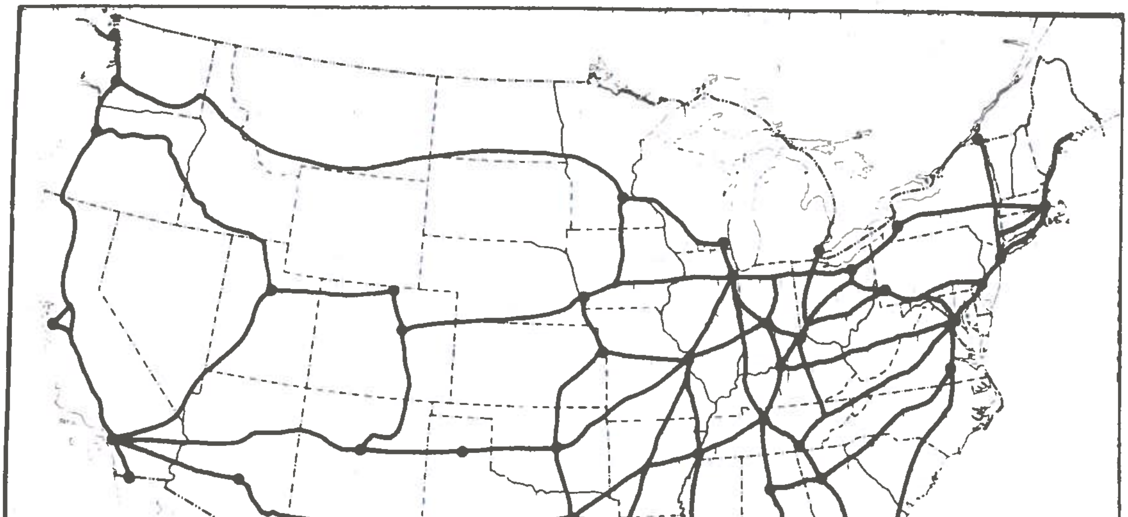


Figure 2. TRAILS Network.

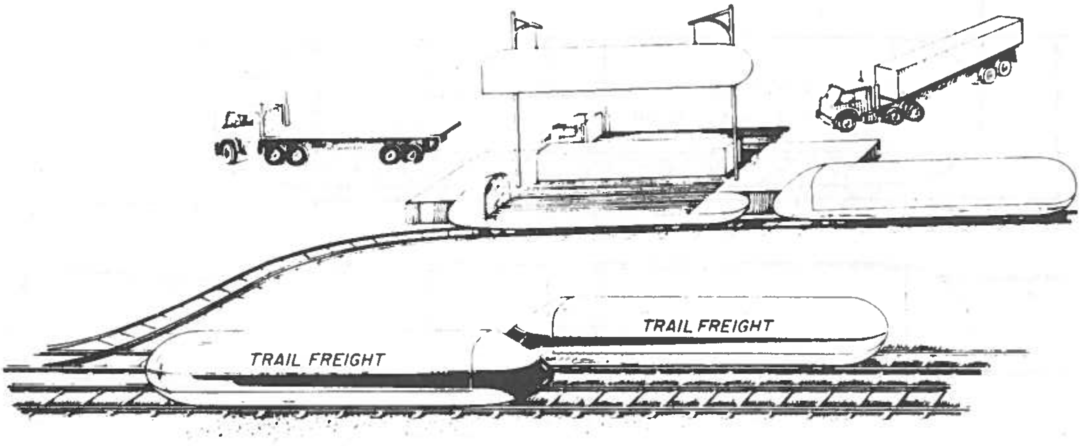


Figure 3. TRAIL-FREIGHT Terminal Operations: Loading 40' Containers.

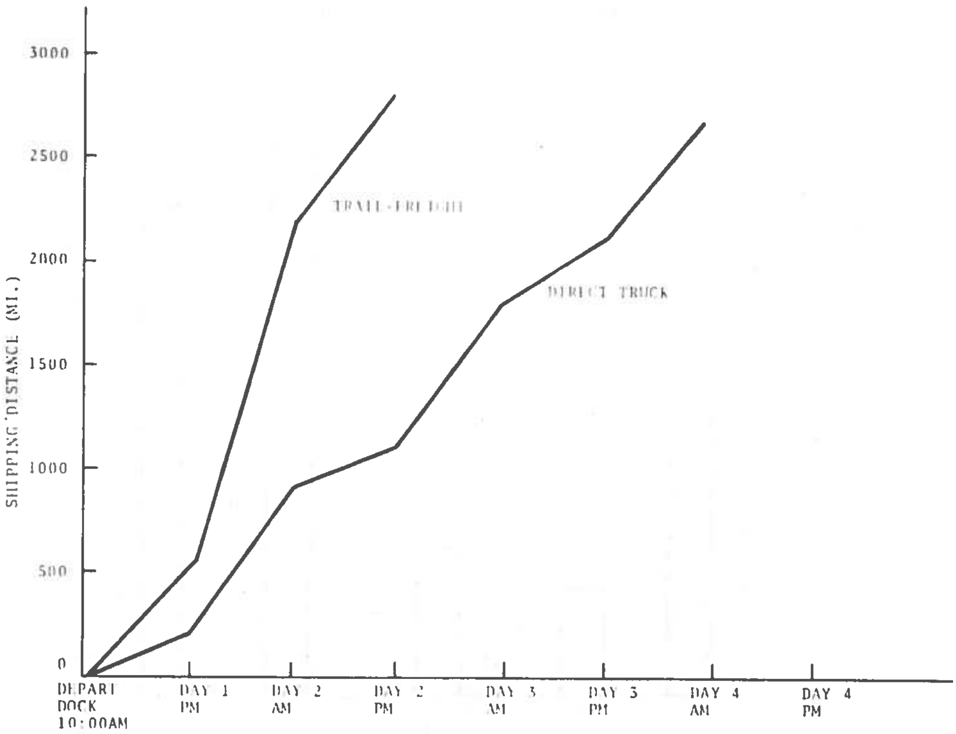
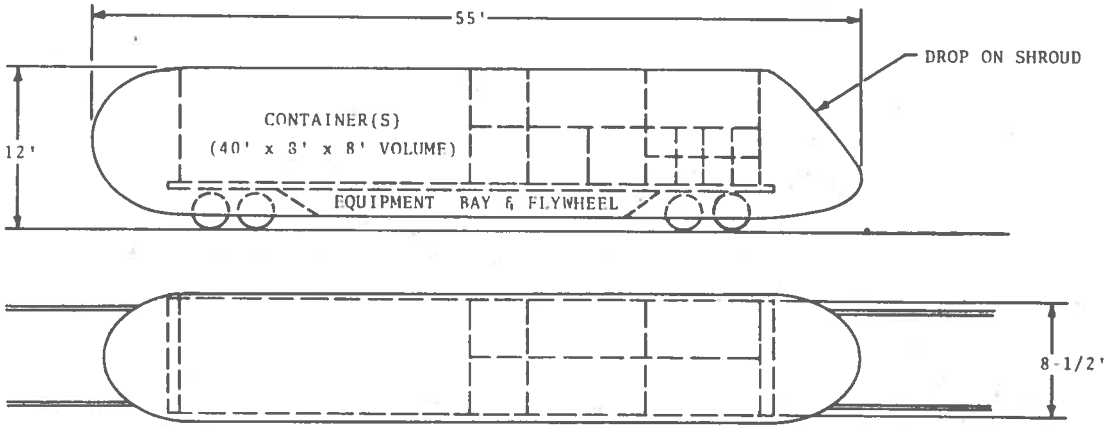


Figure 4. Comparison of Freight Services.



DESIGN DENSITY:	20#/CU. FT.	SPEED:	120 MPH CRUISE
DESIGN CAPACITY:	2650 CU. FT.	ACCELERATION:	0.03g AVE. TO 120 MPH
	25 TONS	DECELERATION:	0.06g
WEIGHT EMPTY:	20,000 LBS.	PROPULSION:	ELECTRIC/FLYWHEEL
		SUSPENSION:	STEEL WHEEL/RAIL

Figure 5. TRAIL-FREIGHT Car.

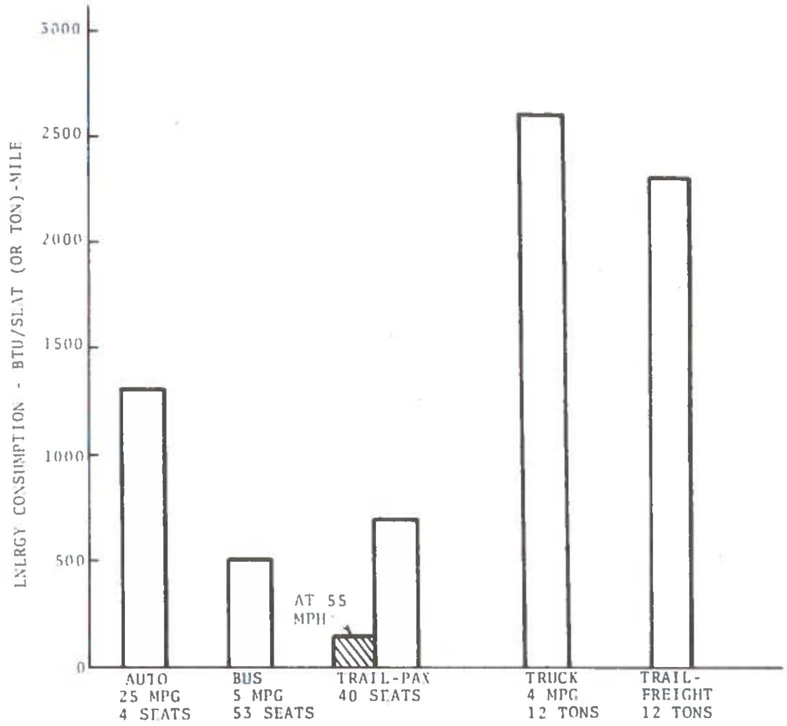


Figure 6. Energy Consumption.

ITEM	COST ($ BILLIONS)
Guideway	
20,000 Miles Including Sidings, Ramps, Switches, Power at $3,000,000 per Route Mile	60
Vehicles	
PAX Cars – 20,000 at $500,000 Apiece	10
Freight Cars – 100,000 at $250,000 Apiece	25
Terminals	
Major – 40 at $50,000,000 Apiece	2
Minor – 200 at $10,000,000 Apiece	2
Passenger Stations – 1,000 at $1,000,000 Average	1
Control System	
At $50,000 per Vehicle in Operation	5
GRAND TOTAL	$105 Billion

Figure 7. Capital Costs.

REVENUES		COSTS	
Freight		Debt Retirement	
30,000,000 Containers 12 Tons/Container 500 Mile Average Haul 5¢/Ton-Mile	$ 9 Billion	$105 Billion at 10% 30 Years	$11 Billion
		Maintenance	3 Billion
Passenger		Operations	1 Billion
300 Billion PAX-MI 5¢/PAX-MI	15 Billion	Fleet Replacement (10-Yr Vehicle Life)	3 Billion
TOTALS	$24 Billion		$18 Billion

Figure 8. Annual Costs and Revenues.

Alan S. Boyd
Vice Chairman
Illinois Gulf Central Railroad

Mr. Boyd, the first U.S. Secretary of Transportation (appointed in 1966), has been associated with the Illinois Central Gulf Railroad for the past seven years. Before assuming the vice chairmanship, he was president and chief executive officer of the railroad and earlier was president of the Illinois Central Railroad. Mr. Boyd is also a former chairman of the Civil Aeronautics Board. In addition to serving on the board of directors for a number of organizations, he is on the board of governors of the Midwest Stock Exchange. Mr. Boyd is chairman of the Railway Systems and Management Association.

LUNCHEON ADDRESS

"THE PROMISES AND PITFALLS OF ADVANCED TECHNOLOGY"

. . . To some degree with the promise of technology in the freight transportation system, we do not see everything we hear about. But that does not mean that it does not exist, or may not be capable of development.

For example, much has been accomplished within the lifetime of most of us in this room. A few items: application of diesel-electric traction to transportation, gas turbine and jet engines, the computer, almost universal use of radio, LORAN, radar, mechanical refrigeration, solid state electronics, long distance conveyor belts, plus many other items too numerous to cite.

I used to say and still believe we have reached an age where we can invent anything we can conceive. Some of the items just mentioned seem to confirm that view. In addition, many of you are aware of CAD — Collision Avoidance Device — for aircraft. CAD not only identifies the problem, it dictates the solution. Further, ACI — Automatic Car Identification — for railroad cars, truck trailers, and containers is a reality.

We increasingly find the questions, "Why don't they?" or "Why don't we?" being answered but there are still many areas for new applications. One reason is that whereas our conference is on the freight transportation system, those of us not in government service have only a piece of the action. Even though we can define or recognize problems, the feeling is strong that individual segments of the system are not responsible for the total system or can live with the problem. Such an attitude provides many opportunities at the nodes or interfaces.

Typical freight movements (other than bulk commodities) may be described as truck-rail-truck or truck-aircraft-truck. Multiple handling of shipments is generally conceded to be inefficient and risky. It leads to loss and damage; it requires manifold records; it represents built-in delay in the movement of goods.

It is almost too elementary to state that the freight transportation system exists for the benefit of shippers and receivers. What we generally think of as the regulated system is not working particularly well. Hence, a continuing growth in private carriage. However, private carriage does not represent any advance in technology. It is merely a shift in control of existing technology to service the shipper.

Given a need to make the system more productive and efficient, how do we go about it? What does technology have to offer? First, one should acknowledge that the computer tied to a modern communications system provides an almost limitless resource for control and information processes. Application to the utilization of rail rolling stock is a most promising area. The same is true of scheduling barge tows through congested locks.

How many observers are satisfied that truck/rail piggyback or container interchange has reached perfection? My own guess is that we have built only a skeleton which will be fleshed out with new machines, new controls and equipment, and new concepts now only dimly seen. There is little doubt in my mind that technology can provide major insights and improvements to the "dismal swamp" common carriage calls tariff publications. The possibilities for expanded use of pipelines in the movement of solid materials are exciting. The same is true of tunneling techniques. The rehabilitation of the dirigible as a modern freight carrier has fired the imagination of a number of highly intelligent people.

Substantial reductions of damage to cargo can be accomplished solely through technology. It is essential to find out why, where, and how damage is incurred. To do so requires very precise measurements related to time. There has been too little of this done to date. One reason is the lack of necessary measuring devices.

The railroad industry can measure engine performance, speed, weight, mass, air pressure for brakes, condition of equipment, components, and track condition. With all these measures being utilized there are still unexplained derailments. This is an area where new technology can help.

The most efficient designs for cargo aircraft and cargo handling systems both within the aircraft and all the way back the chain to the shipper are yet to be developed. One would probably not use the existing system of moving cargo by air as the example of a model of logic.

All of this potential can be achieved. Some of it will, much will be left as only potential. What may be accomplished through advancing technology will follow commitment and appreciation. Without full commitment to change, advance, progress (put in your own term), technology is an empty vessel. To obtain commitment there must be first an appreciation of the value of technological advance.

Such an appreciation tends to stumble on the hurdle of that great organizational concept called specialization. Recently, our vice president, computer and communications, told me he has reported to four different people since taking his job. He asserted that none of the four knew what he does for a living. As one of the four, I could only agree. The point is that so much of our business life is devoted to one facet, we lose sight of the whole. We tend to be suspicious of people in other areas in our own business. In a limited resource area another's desires conflict with my needs. Somehow we must overcome the specialist attitude so we can understand the system possibility.

Once we have reached the happy state of mutual trust and respect – once we open our eyes to broader possibilities – we begin to face some grim realities. The manager attempting to intelligently allocate resources looks at risk and constraints.

To return to automatic car identification, mentioned earlier: it works, it works imperfectly and needs improvement. Beyond that, it costs a lot of money and for a variety of reasons has not been universally accepted in the rail system. Personnel savings from its installation have not been as great as hoped for. Nor has its level of accurate readout provided sufficient hard data on which action may be taken. But the concept may be a good one.

What is the point of one railroad or the U.S. government, for that matter, investing money in a terminal information system for all railroads, for example, CRTIS, when everyone involved subscribes to the concept and can enumerate the benefits to facilitation such a system will bring, and then walks away from the project? Under these circumstances why should any capital-short manager pursue ACI? What rational manager operating a part of any system will invest resources to advance the system unless his counterparts will do the same at the same time?

There is much technology available on the shelf that could be utilized by the railroad industry. Much of it would displace labor with capital. But labor does not want to be displaced. Work rules and crew consist agreements are dedicated to preventing such displacement.

The DC9 and Boeing 737 aircraft were designed to be operated by two-man flight crews. However, the airlines were forced to provide a three-man flight crew. One can only agree with the individual employee's desire for security. Unfortunately, the wolf at the door for railroad employees is most often intermodal competition; labor agreement constraints have exacerbated and intensified the impacts of competition.

Let us assume there are benefits to be achieved through technology. Are the benefits going to pay off sufficiently to warrant the investment? If the answer is yes, then arises the question of whether the payoff in one area is as good as, better, or less than similar investment in another area. All such analysis is based on assumption that new technology, if acquired, can be utilized within the regulatory environment of EPA, ICC, CAB, OHSA, and so forth. Further, that such utilization will be permitted on a timely basis. History would indicate that both assumptions are questionable.

All of which is to argue that institutional constraints too often dictate a jaundiced view of investing in new technology. But institutions have no life of their own. They are operated and supported by people. This raises the interesting prospect of changing people's attitudes and thereby changing institutional parameters. Behavioral science or hypnosis might be called in; but how about using some common sense?

It seems to me that in a conference on freight transport systems, one should think of a system. One approach is an integrated system – a freight transportation company. That offers the rationale for doing something at the nodes. One entity has responsibility for the interface. Another fascinating possibility is that as the movement of cargo shifts from one mode to another, employment could be adjusted accordingly. To do so would require, at the least, guaranteed annual employment, adequate training facilities, and a shift away from union craft concepts. The number and names of union organizations are no more sacrosanct than those of the employers for whom their members work.

A change in the perceptions by labor and management as to what each other is about can create the opportunity for tremendous improvement within the existing structure. Labor has supported specific train operations on the Illinois Central Gulf Railroad using two-man crews. This has resulted in more business for the railroad and more jobs for union members. Such actions improve the atmosphere for the introduction of changed technology.

Fundamental to union support for the new train operation was a prior reduction in train crew employment due to loss of business. Next came a series of presentations to the union on the economics of hauling trainers by train between Chicago and St. Louis. Questions on the validity of figures were raised and answered. Then came presentations on the market for such transportation with consequent job opportunities. Thereafter came agreement.

The point is that perceptions, the environment, and institutional relationships <u>can</u> be changed by people – and only by people. Such changes are essential to permit technology to expand and spread. Good faith and mutual understanding of the situation are preconditions to achievement.

A case where the environment and the freight transport system seem to me to be at cross purposes is the Interstate Commerce Commission created in 1887. The Organic Act has been revised, amended, and updated from time to time. Its historic roots continue to support the regulatory tree. Innovation is a fearsome object to many regulators who, like us, are also captives of their environment. The Interstate Commerce Act, the Commission, and its precedents should be dismantled and decently interred. To the extent economic regulation makes any sense for surface transportation, a new act should be adopted to oversee preference, discrimination, and joint or through rates. The rationale for economic regulation is that it functions as a substitute for competition and dictates cross-subsidization. Trucks, trains, pipelines, and barges are immersed in competition. One must even question the value and relevance of the whole common carrier concept.

One possible alternative to common carriage is subsidy. Let us suppose the public policy is to ensure the small shipper or small town shippers reliable transportation at reasonable rates. Or policy may dictate below-cost rates for the movement of certain commodities.

Could not the government contract for transportation and terminal services on a basis similar to subsidies paid to various airlines for essentially passenger services at points where service is uneconomic? Common carriers of freight could handle this assignment – given legal authority to do so. In fact, many are now performing such services through internal cross-subsidization.

But with such a system is regulated common carriage required?

This is not a plea to put common carriers out of business. It is a proposal for consideration. The businesses now in common carriage would need time for transition. I would expect them to remain in business, so long as they provide a needed service efficiently.

The argument that freight transportation must be regulated because it is a business affected with the public interest is one I find unpersuasive. It is my belief the common carriage concept was grafted onto transportation as a historical accident or fluke. Furthermore, much of the current system is unregulated – and that portion is growing. And many other businesses affecting the public are not subject to economic regulation, for example, food.

Beyond that, my possibly anti-delusional mentality tells me that regulated competition is a halfway house where no one can live for long in good health. To my mind, at least in transportation, true economic regulation ought to relate closely to true monopoly.

Government has a variety of other roles to play. Basic research is a major area. Safety regulation is another – and one where performance rather than specific standards should be the aim. Also, sad to say, there is a distinct need for government analyses to advise the transportation industry as to what its real problems and opportunities may be. Too often within the industry these are obscured by the issues we like to talk about.

Most important, government can articulate the current role of transportation and raise questions as to what purposes the public expects transportation to serve. The transportation market is not a true market in an economic sense. The market has been modified by social and political policies. These should be identified and, to the extent possible, quantified. In addition, government can (in some cases must) backstop the cost of supporting redundant labor forces due to changing technology that will benefit the transportation system.

The advance of technology is generally considered to be desirable. To the extent the mind of man is unfettered, he tends to be innovative. In transportation this requires, at a minimum, a competitive environment with sufficient incentive to make the effort and its product worthwhile. Developing a sense of unity as to the purposes of the transport system will do more to advance technology than any increase in R&D budgets or exhortations to innovate.

DISCUSSION PANEL

"ACTION ALTERNATIVES FOR FREIGHT TECHNOLOGISTS"

Remarks by
Dr. Paul O. Roberts
Director, Center for Transportation Studies
Massachusetts Institute of Technology

As I came up here, someone asked me if I would keep my remarks short. I have considered this and decided definitely that in view of my last talk I should not do so. [Laughter] I find myself in the unenviable position of following Alan Boyd. Like so many "academics" I find that after a good practical man of the world gets up and says something that everyone can understand, the academics then usually get up and in their muddled jargon try to clarify it by putting the thing into "academese." I find that a lot of my remarks – and I actually did prepare them ahead of time – turn out to be restating the same points that Alan has just presented. I would argue, not as eloquently perhaps as Alan did earlier, that it is this trade-off between jobs on the one hand and productivity on the other that technologists have to be concerned with if they are to get their technology implemented.

Let me enlarge upon that just a bit.

Changing technology has wrought substantial human cost in the past. Its potential for doing this in our more highly organized and specialized society is even greater. People who hold jobs in our society realize this and they are very careful to organize the institutions so that it's difficult to make these kind of changes.

Some examples out of our past are the canals and the river boats being replaced by the railroads. Or, a more up-to-date example is the Interstate Highway System bypassing all the filling stations around the edges of many of our rural towns. Some current examples: railroad work rules, or the highway lobby against eliminating the highway trust fund.

Over and against these jobs on the one hand are the advantages to society of low-cost, ubiquitous, high-quality transport. The advantages are very great; they're very subtle, they're very low level. They are like ocean waves, if you will, very low power but lots of them out there. The principal contribution of this low-cost, ubiquitous, high-quality transportation are economies of scale in production in our manufacturing system.

If, for example, you lived all alone with your family in a very remote place with no transport but foot, you could not afford to bring in food since you couldn't carry it far enough. You would have to grow everything locally. You would become a generalist. You would grow your food, you'd make your clothes, you'd build your shelter, you'd gather your fuel. You would keep everything close because it's so much trouble to carry it. But if a couple of other families moved in not too far away, one could specialize in growing food while you specialize in making clothes. The third one might specialize in gathering fuel. Everyone cooperates on building shelter. The specialization would improve the lot of all. And in fact, far before our time these sorts of things happened. It would still be necessary to stay close because a good transport system still wouldn't be there, but we would gain through the economies of scale and specialization of production.

Now what if better transport came along, which allowed you to trade with neighboring three-family villages. Your village might specialize in making clothes, for example. You would get better at making them. You'd have a little bit bigger market, and that bigger market would allow you to carry out the specialization to improve your trade. With a still better transport system, you would trade with a whole country of these same villages. Perhaps you'd make shoes instead of just clothes in general, and you'd make them for very little per shoe. No one could compete with you in making shoes because of your specialization and your very large markets. What the society has done is traded off transport for economies of scale in production.

This new situation, the one we're in now, I would argue, presents society with a tremendous range of choice – tennis shoes, dancing shoes, hiking shoes, wing tips, platform heels, all sizes and colors. This is only possible if we have an efficient, high-quality, low-cost transport system. So we're caught on the horns of a dilemma. One horn: Over the short run it's very difficult to pose pareto optimal changes; that is, changes which improve some without hurting others. The other horn: over the long run if you don't make these changes, society loses the benefits of economies of scale and production through access to larger markets. In our case you wouldn't lose them exactly; they would just taper off. We'd begin to drift toward the high end of that logistics curve.

I hesitate to compare the situation to the terms of a zero-sum game, but that's kind of the way I like to view it. It's an "if you win, I lose" kind of a proposition, at least over the very short run. I

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would hesitate to make the point over the longer run.

Let's now build a new road from A to B. The day the road opens you save gas, use less trucks, have fewer drivers, use a smaller number of tires — so you've saved transport costs, but you've sold less gasoline, you've laid off drivers, you've reduced the purchase of tires, you've canceled orders for trucks. If you measured things at that very instant, the economy would have gone down.

Now if the trucker, who presumably is still hauling and getting paid, still continues to get as much for his trip as before, he may then realize a substantial gain in take-home pay. He builds a new swimming pool, he orders catered suppers, he has a live-in maid. The economy has shifted. In fact, it has shifted fairly drastically. You've had to move from being a truck driver to being a live-in maid.

Now the economy has expended less resources in this whole situation, so society is clearly better off than it was before even though some have had to change jobs. On the other hand, if the trucker distributes his gain as a drop in rates, the savings spread through the economy fairly fast. There are probably less dislocation effects. It's not hard to see why labor unions, equipment suppliers, and so forth, fight change. In fact, we all fight it a little. None of us wants to be out of a job.

Changes in technology cause short-term dislocation. In our highly organized and specialized society, these dislocation impacts may be larger than in more primitive societies. So, the lesson I would like to give technologists is that short-term opposition to change is natural. If you are to have your technology implemented, then you must take responsibility for transition strategy as well as for conception of the final system.

Now with these words ringing in our ears, I'd like to forget these philosophical concerns for a moment and mention some practical problems of the current freight system as I see them. And in view of the multimodal character of the audience, I'd like to direct my remarks to the overall system. They apply to trucks, to rails, to airfreight — some modes more, some less.

I want to mention four problems that I think that we technologists have to address as we face our transport system. You might even think about them relative to the conceptual design for an intercity transport system that we had placed to us this morning. The first one is the line density problem. (I'll come back to each.) Number two is the switching problem. Three is the equipment utilization problem. And four is the interchange problem. The same problems exist with all modes, more or less.

Let's start off with the line density problem. The number of possible routes over our highly interconnected transport system between any two points is absolutely huge. There are perhaps 200 rail routes, for example, between Washington and Chicago. Of these some 20 are actively used. Let's also suppose that we had 20 cars going from Washington to Chicago. Now, if you divide the volume of freight cars that are moving between Washington and Chicago on a daily basis over the 20 lines that we said were actively used, you are now down to one car per line. I would just make a remark here to say that I'm not sure exactly how you know that 20 cars flow between Washington and Chicago, or between any one place in our transport system and any other, because it's very difficult to get that kind of information from published transportation resources that we have at the present time. But let's assume that is the correct number. This one car per day must be connected with others in order to be able to offer any service at all between Washington and Chicago.

Why, you ask, does this ridiculous situation continue to exist? Our regulatory system says that the same rate applies regardless of the route taken. So, carriers maintain freight sales offices in places they don't even offer service just to sell freight. Shippers are asked by the freight salesman to specify MY railroad because it doesn't cost you anything to take MY railroad even if I am a little out of the way (on the route between Washington and Chicago down in Texas somewhere). I don't have any solution to this particular problem. I just want to state the problem. There is no mechanism which tends to increase line density by placing freight on the shortest route.

This leads me to the second point, the switching problem. In the Potomac Yard the dispatcher may find this one car in Chicago, and he'll throw it on a train to Baltimore because he has got to get it up to enough volume to make it possible to move the train. In Baltimore it's reclassified. It's reclassified again in Philadelphia, and reclassified again in Pittsburgh, and reclassified again in Akron. In fact, with these line densities down every few miles down the track it's having to be reclassified in order to get enough density to go to the next point.

It's my feeling that switching costs are higher than anyone is willing to admit. It is difficult to assign these costs to any one car, or to any one shipment, but they are there. The more visible line haul costs are dominated by the fixed costs. The four-man crew has problems because of a rigidity in work rules. The dispatcher wants to get as much out of that four-man crew as he possibly can. If line densities were up, he could run more through trains. He could offer direct service. He could pick up and set off without reclassification. He could avoid high switching costs — even give better service. The same is true with trucks. As you go from one point to another the vehicles are having to stop and reclassify loads in order to get the volumes built up for the line haul segments.

Let's go to the third point: the equipment utilization problem. On rail more than truck, a tremendous amount of the equipment spends most of its time sitting around waiting around to move. We talked about some 8 percent of the vehicles moving with a paying load. People say that the reason that rail is chosen is that it is a moving warehouse. Also, once a freight car has been delivered you don't have to load or unload instantly; you can order cars and let them sit. You can reconsign and so forth. So there's lots of advantages to using rail. I'm sure that some of these reasons for using rail are true but this ties up a lot of capital unproductively. There are per diem and demurrage charges that recover a portion of these costs. However, I would argue that the actual cost is much higher than the charges that are currently made. You don't see the trucks loaning out their trailers. If they have a piece of equipment they use it. There's also a high rate of equipment interchange in rail, and this also contributes to poor utilization.

The interchange problem, which is my fourth and last point, alludes to the fact that a very large percentage of rail shipments originate on other lines. I don't know the exact percentage which originate and have two or more carriers involved, but I'm sure it's a fairly large portion. This causes a number of problems. Service quality is one. Service quality is less with more carriers interchanging than it is with one carrier. There's the loss and damage responsibility which Alan Boyd mentioned. It is easier with one carrier to identify who's responsible. There's also the automatic reclassification. It's not necessary but it frequently happens. The operations are carried out at the convenience of the originating carrier, not the terminating one. There's a haggling over the split of the revenue. There's also difficulty with filing separate rates. So the problems with interchange don't mention the problems with system compatibilities, joint decisions on system-wide changes, and so on.

Where does all this come out? I believe that if we can solve some of these institutional problems, perhaps even using our advance technology to do this solution, then there are great possibilities for increased savings and even for application of still more advanced technology. Our present concern should be that our institutions are frozen. They must be freed up. We must, however, recognize that society likes the protection afforded by this stability, and change will only come by designing for it.

DISCUSSION PANEL

"ACTION ALTERNATIVES FOR FREIGHT TECHNOLOGISTS"

Remarks by
Dr. Aaron Gellman
President, Gellman Research Associates

I find myself in a strange position. This is the first time in my life I've been to a conference, and found very little with which to disagree. I suppose that's because almost everybody here is beginning to see the same vision with respect to the exploitation of technological possibilities in transportation. Most of us are recognizing that the problems are largely non-technological at this time; the problems are mainly institutional. And I believe this is a very happy situation.

As I see it, under these circumstances the future is far brighter now for those in industry, for the country as a whole, since we rely so heavily on technology and its efficient exploitation. The future is much brighter now than it was before we came to realize that the process of innovation is an important one and we ought to know something about it.

Having said that, I would also observe that I find myself very much in the position of Zsa Zsa Gabor's seventh husband when they were first married. He didn't know what there was he could do that was new. [Laughter.] In any event I shall try as I suppose he did.

I have identified 11 significant non-technological factors which I believe impinge upon the process of innovation. These factors bear particularly upon the post-R&D elements of that process, something I have chosen to call the "technology delivery" aspects of the process of innovation.

I will run through these 11 factors very quickly and then discuss only a few of them in recognition of our time constraint. As I proceed, please remember that these are non-technological factors that impinge upon those who would work through the process of innovation to get a technological possibility — an R&D result — introduced into the marketplace where transport inputs and outputs are bought and sold. Also keep in mind that all 11 factors may not be operative in a given innovative process.

The first of these 11 barriers is the disaggregated market for freight transportation services. This constraint is enhanced by the widespread unsophisticated handling of traffic management or logistics management decisions in this country. Now this is a very tough problem to deal with. There are myriad shippers out there. And this kind of a problem requires a great deal in the way of market analysis and research to understand and come to grips with the situation. (In passing, I would point out to you that we know virtually nothing in this country about how shippers make routing decisions. The only study of any significance that I have been able to put my hands on that really gets at the problem was done in England in the late 60's by Allen Walters, now at the World Bank, and Johns Hopkins University. More than any other research, this study showed some amazing things about how shippers make decisions. I suspect that Walters' research program ought to be duplicated in the U.S.)

The second barrier is the disaggregated market for freight transport equipment and components. There are numerous enterprises in the market for freight transport equipment in most of the transportation modes and this represents a substantial barrier to innovation in and of itself. (I wish we had time to discuss it in some detail. We don't.)

A third major barrier relates to the heavy capital investment and long depreciation periods in both the equipment supply and carrier fields. One issue here I cannot forbear mentioning: How hardy, how durable does freight equipment and infrastructure really have to be? What is the picture that potential entrants, potential innovators, see when they face the exceedingly durable hardware and infrastructure that has characterized most of freight transport through the years? It may be that it is absolutely necessary that it be so hardy, that it be so durable, but I am not so sure. And as far as I know no one has looked at this issue in any systematic way.

Fourth is the feast-or-famine character of the demand for much transportation equipment and infrastructure. This point has been touched upon here by a number of people, either directly or obliquely, since we started yesterday morning. Suffice to say that it is a very difficult decision that you make when you are undertaking to analyze an innovative possibility either to expand your product line, if you're already in the business, or to enter the business if you're not. It is a very difficult thing to find that the market you want to serve is characterized historically by feast and famine. That is not the place to get high returns on investment. And I submit to you there are many

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things that government and the carriers can do to help ameliorate this problem.

The fifth of these barriers relates to the high concentration ratios in the transport equipment and component supply industries. I will come back to this one since it bears talking about in more detail.

Sixth the character of much of the economic regulation that is applied to transport enterprises represents a very substantial barrier to beneficial technological innovation. I will also return to this problem.

The seventh of these 11 barriers relates to the character of certain labor agreements between carriers and unions. Since Alan Boyd did admirably with this one, I do not propose to say anything more about it.

The eighth: the uncertain impact of environmental protection upon innovators in the transportation sector represents a far more serious barrier to innovation than you may recognize. I am not saying such barriers should be dismantled totally. However, I would urge that we recognize environmental concerns as a barrier and discipline ourselves to determine whether the benefits derived from such concerns are worth the cost that we bear in terms of forgone innovation — as well as in other ways.

The ninth non-technological factor concerns the general failure to identify and failure to resolve satisfactorily those cases where the net external benefits flowing from a transport service are great enough to justify a carrier's receiving sufficient public financial support to encourage it to offer the service even where the revenues derived directly from the marketplace are inadequate to support the service. We have yet to deal properly with the myriad externalities, at least in terms of the process of innovation.

The tenth point is that a very substantial and rapidly growing barrier to the exploitation of technological possibilities grows out of the manner in which R&D procurement is carried out and the motives for "buying" R&D results. I will also return to this subject.

At last, the eleventh constraint: In the growing instances where federal support for R&D is involved, the denial of exclusivity to a private entrepreneur in exploiting the R&D results greatly reduces the likelihood of private sector interest in any exploitation of a potential innovation which requires devising and working through a complex, resource-consuming "technology delivery system."

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Now let me return to the three points that I believe should be elaborated upon at this meeting.

The first of these is the high concentration ratio often found in the transportation equipment and component supply industries. (Technically, the concentration ratio is that proportion of a market enjoyed by the top four firms which serve that market.) For many major inputs to the transportation production process, there are a very limited number of suppliers. In general, where there are exceptionally high concentration ratios there is a tendency for innovation to be relatively slow-paced. Moreover, several studies demonstrate that the longer high concentration ratios persist, the less likely is it that there will be an aggressive program of innovation.

Now, the high concentration ratios are not entirely the "fault" of the suppliers, although they may benefit materially from such a situation. Much of the responsibility for high concentration ratios rests with those on the demand side of the equation — customers who do not purchase in such a way as to induce even well-established suppliers to look to their technological laurels. Such customers do not force new entry on the supply side where new entry is warranted. Therefore, one obvious suggestion is that a very effective way to improve the technology delivery process in the transportation field would be for producers of transportation to buy much "smarter" than is now generally the case.

The purchasing function, in my view, is one of the culturally deprived areas of transportation, and that ought to be remedied. I further believe that TSC and DOT have a very large responsibility to do something about this situation. And I would observe that it is not very difficult to improve things in a case that is as bad as this one generally is in the transportation business. I want to stress that only if we improve the purchasing function will present suppliers have to reach out to the frontiers of technological possibility — only then will the market appear sufficiently attractive to outsiders to induce them to assault the barricades of those marketplaces and become suppliers of inputs to transportation.

In the same connection it is worth noting that the R&D programs of government as well as those sponsored in whole or in part by a typical firm or trade association should certainly be oriented towards assuring that competition in transport input markets is sufficiently high to guarantee that a majority of the technological opportunities that are available are in fact exploited in timely fashion. To aid in improving the conditions of supply in transportation, as measured by the ultimate efficiency and market responsiveness of the carriers, I would suggest that both DOT and transport firms should explore the extent to which "true" performance specifications have been met or exceeded by suppliers (or potential suppliers) to the relevant markets. While this comment presupposes that the performance specification is to be used as a technique for overcoming the market aggregation problems in transportation, it also hypothesizes that publication of a reasonable but tough performance spec will induce substantial competition in transport equipment and transport component markets.

I cannot forbear observing that, in my view, the several R&D elements of DOT and TSC would be rendering an invaluable service if they would devote the modest resources required to determine what constitutes a true performance specification — a spec which is not biased in favor of existing, entrenched suppliers of such equipment or components of fixed plant. Performance specs should be oriented toward function. The item to be procured should not be described in purely dimensional terms. The economics of acquiring and operating the innovative equipment should be an explicit element in the performance spec. Once more, the specification should force those who respond to reach to the frontiers of technological possibility in order to meet the specification. Moreover, it should be explicit that the performance specification will be republished periodically as technological frontiers advance so that the transportation industry is constantly being offered equipment and components which take full advantage of such technological possibilities.

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The character of much of the economic regulation applied to transportation is often a substantial barrier to innovation. Where it is not a barrier, it frequently distorts mightily the process of innovation — which is sometimes worse because of the long-term and dynamic effects of such distortions. There can no longer be any doubt but that economic regulation is not neutral as to the technology employed in regulated transportation industries. We desperately need to demonstrate this fact as dramatically as possible. Economic regulation absolutely does affect the investment decisions and the technological choices of regulated carriers as well as of their suppliers and their customers. Perhaps the most effective way to dramatize this is through a series of case studies describing situations in the various modes where there has been a discernible relationship between economic regulation and the process of technological innovation. Myriad cases exist. One example which is pregnant right now concerns Part 298 of the Economic Regulations of the Civil Aeronautics Board, and particularly with respect to the implications of this kind of regulation for Federal Express and other (who knows how many?) potential entrants into the air transportation business.

Economic regulation often stands in the way of the transport industry's exploiting technological possibilities. Who needs to be convinced of this? Policy makers at each and every level of government, state, federal, and local. Regulators themselves. Legislators. Carriers and their suppliers. Few of them seem to understand this fully. For example, when I gave some testimony recently before a congressional committee I mentioned the Part 298 case just referred to — where economic regulation is directly limiting what airframe and engine manufacturers can do in the development of freight- or passenger-carrying aircraft. On this occasion one member of the House asked "Do you mean to tell me, Professor, that economic regulation of the CAB limits what an air carrier will want to buy or can buy in the way of aircraft?" And I said, "Yes sir, that's exactly what I do mean." He looked around at his colleagues and said, "How long has this been going on? We ought to do something about that!" |Laughter| . . . The important thing is that we really do have to do something about understanding this sort of relationship . . .

Perhaps one of the most important single contributions DOT can make in this general respect is to begin on its own initiative to prepare what I have come to call "technology impact statements." DOT should consider producing these although they are not required at the present time; the "TIS" should be introduced in relevant hearings and regulatory proceedings where there is a likely relationship between an economic regulatory policy or decision on the one hand and the technological innovative propensities of the regulated and their suppliers and customers, on the other. Introduced into appropriate records, such technology impact statements would then be supported or challenged by others with an interest in the particular regulatory proceeding or legislative hearing . . .

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Finally, I will address the non-technological factor which might be most sensitive given our present location and the sponsor of this conference. I refer to the twin issues of transportation R&D procurement methods and R&D procurement motives. Here we have a rapidly growing, though subtle, barrier to technological innovation and a barrier which has not been recognized previously. What I am suggesting is that the way in which R&D is carried out makes a big difference in terms of its subsequent exploitation through the technology delivery process which leads to the market.

Over the years, public bodies, including DOT, have become a growing market for transport R&D "results." This contrasts sharply with earlier times when the demand for R&D activities and for R&D results emanated primarily from private sector entrepreneurs who stood ready to convert the results of successful R&D into marketable (and therefore profitable) products and services. Where the demand for R&D is separated from the hardware (or service) production and marketing responsibilities, the R&D result becomes an end in itself; this in turn guarantees that such R&D will be far less relevant to the marketplace than were there no such complete decoupling of market demand from the R&D function.

When a government agency "buys" R&D results, for the supplier of that R&D making a profit or breaking even on the R&D the project becomes an end in itself. He has little or no interest in expressing the results of the R&D in terms which promote their exploitation through the technology delivery process into the market. Moreover, where R&D is being produced under contract by the R&D arm of a firm that has the capability to manufacture and market transportation systems and components, there is a double loss to the economy. This happens because while the research unit of the vertically integrated enterprise is turning out an R&D "product" for its external customer — government in most cases — that R&D element of the enterprise is not available to serve the manufacturing and marketing arms of the same enterprise. And that is a real loss. I was at one time in senior management of a large company, and when tough sledding came the president, with the Board of Directors' approval, said to the R&D director, "Support thyself," meaning "Go get contract research." As a result, there was a decoupling of the firm's R&D objectives from those of the firm overall. Now the object of the game for the R&D manager was to make a profit directly on each task undertaken for the external client. The unit became a contract research house, for government mainly, and the long-run benefits for the corporation of having that R&D arm diminished very rapidly and in a surprisingly short period of time. I would also suggest that this phenomenon is difficult to reverse which makes matters still worse.

Public sector purchasers of R&D "results" should be aware of the issues just discussed. For one thing, it is very important to maintain well-balanced, vertically integrated firms in the transport supply fields. Again, it is crucial to assume that there are always people in industry with the capability to do R&D that is relevant to the markets served by their firms. I would suggest that where hardware-oriented R&D results are being acquired by public bodies that do not themselves operate such hardware, it might be wise to review procurement practices and policies to assure that the very method and philosophy underlying the acquisition of such outputs do not themselves thwart the achievement of the broadest objectives of the public agency which must in part relate to transport sector performance in the long run.

I want to make it very clear that I believe there remains both hardware and basic research to be done and that government has a central role in this regard. Surely the net external benefits are so great from certain R&D activities that public-sector sponsorship is warranted.

I would cite a few examples: we need to know a great deal more about what I call "medium resistance." I do not mean "medium" as compared to "high" and "low"; I refer to the medium through or over which things move: air, water, pavement, and so forth. In many areas there is a great need to know much more about the resistance of bodies passing through or over such mediums. Again, we need to make special efforts to improve the deceleration systems in every mode of transportation that requires them. Also, there is much work to do in the signaling and control fields — not only in the railway and other fixed right-of-way modes but in those such as air and water, where there are greater degrees of freedom . . .

I could go on but I will not. I do believe, however, that it is appropriate to end where I began. At present, the greatest problems where technology delivery is concerned are cranial, not technological.

DISCUSSION PANEL

"ACTION ALTERNATIVES FOR FREIGHT TECHNOLOGISTS"

Remarks by
The Honorable Hamilton Herman
Assistant Secretary for Systems Development and Technology
U.S. Department of Transportation

I haven't had the time to go through all that has been said in the last two days and arrange it in a neat summary. So, I think what I'll do is just give you a few thoughts off of the top of my head.

I might first of all comment on one or two things that Aaron Gellman said.

Firstly, as to what the government is doing about R&D. Our policy in DOT is not to develop hardware, but to try to have that development done within the industry where it generally belongs – except in those areas which he referred to where we are involved in operating the hardware. And that's in the case of the Coast Guard and the FAA; they operate the hardware. But even there a great deal of their work is farmed out to Ramo-Woolridge and other firms. So I don't really think we are going to get into it very deep. He made a plea for technology impact statements. And I like that . . .

We are in the middle of doing our own homework on technology impact statements. We have addressed the key transportation issues in each of the modes and between the various modes, and having done that we have then taken a look at the technology that relates to those issues in the modes and between the modes. We then have arranged the priorities for those technologies. We've done this in a mutual effort between my office and Bob Parson's office on rail and the other offices throughout the department. You might say this is a real "hard-nosed" inventory attempting to relate the needs of transportation to the R&D efforts that we are either doing ourselves or sponsoring.

Now this is doing a lot of good for us, but the problem is that there are areas where you really do not know what you're talking about. And one of these Sy Herwald and Al Boyd are helping with is the National Academy of Engineering Transportation Committee, which is studying issues in the freight area in the trade-offs between the different modes.

We have just finished in the government (and you may wish to know about it) a major study on fuel efficiency Motor Vehicle Goals and Commercial Motor Vehicles from 1980 forward. This study points out the kind of energy savings you can have in that area. It also points out one of the points that Bill White from Consolidated Freightways made yesterday. If you have bigger trucks on the highways, you can have more efficient use of truck freight, and you can save energy, and so on. And of course that gets the railroads going because they say, "Well, we need the business and we can really do it more efficiently." And then you say, "Well, all right. Where's the trade-off? 500 miles and so-many thousand pounds, or 400?" The truth is that nobody exactly knows where that trade-off is. Therefore, if you say to me, "Give me the right technology impact statement and tell me where to draw the line between rail and truck," the truth is I really don't know. But we do have a major program going to try to figure some of these things out. So then we'll have better guides to decide what we really ought to be working on because if the truth is that your final impact statements would indicate that you should not be expanding the weight-carrying capacity of your federal highways, it would be nice to know it before you went and did it.

All right, so much for the technology impact sort of thing and the hardware sort of thing. One other comment on Aaron's comment on procurement – our area, this is a problem. Sole-source procurement and really innovative support is hard to do in the government because they want competitive bidding. In addition, you have lengthy procurement procedures which you have to go through – regulations. And speaking as one who came out of industry and then went with the government, it takes a year and a half to do what I would have done in no more than a month or two. That's too bad. It's gotten this way because of, I suppose, misuse sometimes of the procurement process in the government.

Now I better set aside the institutional discussion because it has been well talked about; and I don't think it's my function here to talk about the fact that the institutional barriers are the number one reason why technology sometimes doesn't move the way it should move, particularly in such areas as rail.

I would like to come now to my list of questions I gave yesterday noon and repeat them, because I still think they're worth asking. Let me just whip through them.

If we looked at the necessary product improvement possibilities that are going on (and we're talking about containers, weight of freight cars, location, improved use of air freight, improved use of the waterways, possible use of slurry pipe lines, all these things whereby we're using current technology and current operations in a product improvement capacity), we have to ask ourselves if we believe that we can't have better freight terminals for much improved handling of freight within a mode, but especially between modes, which has come up several times. Do we believe we cannot have freightways of tomorrow which will move intercity goods much faster, more flexibly, and more efficiently? Do we believe we cannot have much more efficient urban goods movement including automatic systems handling of both people and goods? That we will lack the political courage to require proper scheduling of loading and unloading operations such as in New York City, and the political and management courage to change the regulations? That we cannot have better flow control systems (and now we're talking about the flow of freight both as a function of time and through the entire system) which will permit more optimum flow of freight than we now have (and this is being worked on)? That we cannot and will not develop much better automatic warehousing and material transfer systems?

I say we can. That, indeed, adequate future mobility would not come to what I said yesterday — "jillions" of dinky cars and rubber-tired trains. I frankly believe that we will not have only the product improvements that we need in our present system; I am personally optimistic enough to believe that we will find some way to get around some of the institutional barriers and look at some really exciting ideas such as what Gary Watros laid on the table and Frank Piasecki with his vertical lift heliostat.

I think Gary Watros brought up a couple of very important points. When you get all the way to the bottom of it, whether or not his system pans out, it brought up a real question for us. That is: let's assume that what he said about 120 or 110 miles per hour was true, and therefore you didn't have to have the heavy trucks that Consolidated Freightway was talking about — and you found this out after you had passed a law allowing 120,000-pound trucks and after you had rebuilt your interstate highways to handle those loads. Where would you be? Gary is saying that under his approach you don't have to do that. And you're talking about billions of dollars of expense on the federal interstate highways.

In his discussion, he also highlighted another key question that's been bothering us (and Larry Green and the FAA and others who recognize this); that is, we've been looking at the problem of what to do about air transport in the future. If people aren't going to allow you to build bigger, larger airports, then what are you going to do as the traffic builds up? Well, you try to automate your current operations, and that gives you some room, but not enough. So you say, well you're going to wind up with a whole bunch of satellite airports, and then that says you're going to wind up with a bunch of different kinds of short-haul airplanes. Then that says it's going to impact your air traffic control system and collision-avoidance schemes and all that sort of thing.

Well if you follow that scenario (and that's the one that people are sort of following at the moment) what happens if Gary comes along with his high-speed ground system and you don't have to have all of those satellite airports, and you don't have to come up with all these new airplanes and crowd the air? Not that you won't still have a growth in air transport — but he is pointing out that if you have a possibility of handling 200 to 500 miles on the ground, that would be a major change in the direction of high-speed ground transport. And I'm merely saying that these two technical possibilities would make a major change in what you would do otherwise.

I think these are the kinds of questions that you really have to look at to be sure that you don't just "mechanize the horse," as I discussed with you yesterday, in delivering the mail.

Now, my final thought is that I think this session has been tremendously valuable. We've got a lot of real good, smart people talking to each other. And we've got a lot of these issues up on the table. But I don't think we're anywhere near done, and my personal plea would be that we keep it up, that we have more of this kind of interchange, that we take a harder look at some of these problems, that we don't allow ourselves to be inhibited by merely product-improving what we did yesterday.

Question: (Addressed to TSC) It is difficult to direct this question since it applies to most if not all those interested in transportation planning, but, what are the most critical data needs for both government and the private sector in attempting to plan and design the freight system of the 1980's and 1990's?

Answer: The most crucial data need is (and will remain through the 1980's) a consistent, yearly modal commodity flow data base among U.S. regions. Although the Census of Transportation will include bulk commodity flows in 1977, collections from manufacturing establishments only on a five-year interval basis are not sufficient to analyze future transportation requirements. Economic market demands for transportation services change rapidly and require frequent monitoring. A yearly, 100 percent coverage of modal flows by four-digit commodity code among BEA areas at a minimum is required. Secondary data needs include inter-regional modal transportation rates, transit times and link capacity data, as well as private investments in transportation facilities.

CLOSING REMARKS AND SUMMARY

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Before I get on with my brief summary remarks I want to take this last opportunity to express to Charlie Baker, Frank Remley, and the staff at Harbridge House, as well as to the many people on my own staff here at the Transportation Systems Center, my personal thanks for what I hope you too have found to be a rewarding two-day session.

During the last 36 hours we have heard four major addresses, listened to over 40 professionals, and participated in numerous informal sessions on the strengths, problems, and requirements of this nation's Intercity Freight System over the next 25 to 30 years. Strong views have been expressed! Advanced proposals and ideas have been presented! Disagreements and opposing positions have emerged. Because what we heard was conflicting, we run into what Scammon and Wattenberg, in their book, The Real Majority, call the "Law of Simultaneous but Contrary Truths" cropping up everywhere – this is true, but so is that, but somehow the two truths don't always coincide. We are dealing with no simple subject! Rather we are discussing something vital to the future of the republic, or as Ham Herman put it – we are discussing either a sad sunset or a glorious sunrise.

What in fact has been said? As I listened I kept hearing a common thread; the opportunities for technology advances in freight transportation are enormous! But I also heard something else. Realizing those opportunities is not easy and indeed the challenge may be greater than it has ever been.

This conference has had several objectives. One is to identify high-potential areas. Another has been to identify obstacles and explore ways of "getting there." I think our conferees have done this in spades, for which we are truly grateful.

Let me recap a few highlights, which the just-concluded panel has considered in various ways.

John Barnum emphasized that although we cannot define the "optimal freight system" of the future, we must attempt to identify transportation requirements and capabilities of the future.

John Meyer saw mostly evolution not revolution, although new technology may well decide such uncertain futures as slurry pipelines and air freight.

Several people, including Sy Herwald, noted that success in finding more efficient ways to utilize the system we have, and in the selective expansion of that system, will be crucial. This view was endorsed by John Ingram when he observed that the major opportunities for railroad improvements lie in the "systems" area.

Judith Connor and Ann Friedlaender urged us to increasingly recognize that transportation has many values to consider, and motives behind our actions are not always clear. They are, as I mentioned before, sometimes conflicting.

Our many-faceted crystal ball clouded up when we tried to foresee the future of energy. In weighing forecasts of petroleum prices and supplies, the efficiency of alternate modes, the prospects for new propulsion systems, and the contribution of energy costs to total modal costs, one view emerged of absolute increases in shipment costs by all modes – but no change in relative modal costs significant enough to reallocate large volumes of traffic between modes.

I was grateful for Bill White's candor in acknowledging that part of his motive for coming was to try and understand what the Transportation Systems Center is about, and what the Department of Transportation might be planning to do to – as well as for – his industry. Those of us who represent the government are here for the same purpose – to learn more about your industry, its insights into our common future and common problems.

Each of you must decide what, if anything, you learned about the future that you didn't already know. Charlie Baker is fond of comparing it to spilling coffee on a dark suit – it doesn't show much, but it gives you a warm feeling. On the other hand, since we must plan for the future despite its uncertainties, it is important to know if your views of the future are shared by professionals whose judgment is respected.

It's worth repeating here Gerry O'Donahoe's observation that there is another part of government – Capitol Hill – that is a big part of the equation. And as Dick Terrell so eloquently noted – we are all in this thing together! Alan Boyd's remarks, from the unique perspective of both top government and industry positions, underscored this!

This morning – in an "O.K., let's get to it" display of technological creativity at its best – we saw and heard a number of exciting ideas. In fact, the possibilities appear to be endless.

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*Prepared for conference but not delivered because of time constraints.

What does this mean? To me it means this conference has made a start. We know better some of the possibilities, and we certainly know some of the obstacles, of which one is, and at times contradictory, a not fully informed government. Good information, the kind required to make major transportation decisions, has been missing. However, this is as true for industry as for government.

We bear the responsibility to start now the painfully slow process of developing our understanding and information bases in these new areas, and of altering the way in which we define and approach issues. For example, Linda Billings was not alone in her recommendation that we must stop treating environmental considerations as a "guard afterthought."

You have just heard Lou Roberts and his panel consider "What now?" and certainly the groundwork is laid.

Let me leave you with this thought. Rome was not built in a day any more than we here have solved the freight problems of the future today. But we have made a start. We are building upon the Committee on Transportation's efforts Sy Herwald talked about this morning. We have gotten a wide spectrum of the public and private sector together in common to address this complex, but critical, area. In short, the first steps have begun! The Transportation Systems Center has learned a lot – so I suspect have all of you. But the process must go on. I assure you the suggestions made have been heard, the ideas have been registered. And we at TSC gladly accept – I hope along with all of you – the responsibility for keeping the assault on the problem in high gear, and making sure that the sun in the distance is a sunrise and not a sunset.

I thank you all for coming.

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