Forecasts of Freight System Demand and Related Research Needs: Proceedings of a Workshop (1979)

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FORECASTS OF FREIGHT SYSTEM DEMAND AND RELATED RESEARCH NEEDS

Proceedings of a Workshop

June 12-13, 1978
National Academy of Sciences
Washington, D.C.

Conducted by

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Assembly of Engineering
National Research Council

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PREFACE

The papers collected in this report constitute the proceedings of a workshop convened by the Committee on Transportation of the Assembly of Engineering, June 12 to 13, 1978, at the National Academy of Sciences in Washington, D.C. In the course of ongoing work to comply with its responsibility to advise the federal government on the policy and technology of freight transportation, the committee had identified the need to improve the forecasting of demand for freight movement as a particularly pressing issue. The workshop brought together 120 participants who represented a broad range of active interests in freight movement and forecasting. The participants are listed on pages 187 through 190.

The U.S. Department of Transportation sponsored the meeting under its Program of University Research.

The presentations and discussions recorded in these proceedings represent the views of individual speakers and workshop participants, and do not necessarily reflect the views or policies of the National Research Council, the Committee on Transportation, or the U.S. Department of Transportation.

In organizing and conducting the workshop recorded in these proceedings, the Committee on Transportation sought to encourage ample and informed discussion of the trends in demand for movement of the principal categories of freight over the next 15 to 25 years, the methodologies now being used or developed to forecast demands on the freight system, and the research needed to support forecasting. Accordingly, experts were invited to address aspects of these issues particular to their interests as forecasters, researchers, policy makers, shippers, or freight carriers, and to engage participants with related but different interests in discussion.

The presentations and discussions of the plenary session were organized under the headings

Aggregate and Major Freight Category Demand Estimation
Transportation Modeling and Freight Demand Trends
Corporate Planning--Major Freight Category Trends in Shipment of Manufactured and Bulk Commodities

Klein and Loxley, for example, estimate the growth of the Gross National Product through 1995 and the growth of the demand for movement of some 25 major commodities. They deal with general economy modeling and related transportation modeling in their demand estimation process. Wild and Bentz discuss their approach to projecting future transportation

freight system demand--both national aggregated demand and regional demand. They dealt with their modeling approach, and with factors affecting demand over time. The speeches of Herwald, Davis, and Springrose give a historical account of corporate decisions taken as transportation of freight shifted from rail to trucks, the problems shippers face today (Will the energy-efficiency of trains for long-distance movement give the advantage back to the railroads in energy-short times? Will changes in policy favor motor carriers, or will improving technology and policy emphasis favor railroads?), and an account of the particular problems of a shipper for whom transportation represents the single largest cost of doing business. Dotter discusses the shipment of energy commodities, particularly coal to electric utilities. The availability of energy to fuel the freight transportation system, and rising prices in the future for energy, come up frequently in the speeches and discussions recorded here.

Davis and Lawrence talk about the long-range planning essential to the operation of railroad and motor-carrier industries, respectively, and the role played in such planning by anticipation of shipper demands and public policies.

Panel meetings were held the second day to explore the following subjects in detail: Aggregate Demand and Research, Durable Goods Demand, Non-Durable Goods Demand, Energy Commodity Demand, and Other Commodity Demand. The summary presented by each panel to the final plenary session is included, as well as a summary of the addresses by the workshop chairman, Dr. Berry, and a summary by Dr. Roberts of the important research needs identified during the two-day workshop.

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WELCOME

Raymond L. Bisplinghoff
Vice President and
Director of Research and Development
Tyco Laboratories, Inc.

I would like to extend to all of you on behalf of the National Academy of Sciences, the National Academy of Engineering, the Institute of Medicine, and their National Research Council a most cordial welcome. I think this is going to be a very interesting and valuable workshop, and I know, as all of you do, that we are looking forward to hearing the speakers.

The Assembly of Engineering's Committee on Transportation is the research council activity conducting this Workshop on Forecasts for Future Freight System Demand and Related Research Priorities, under the sponsorship of the U.S. Department of Transportation's Program of University Research. I find in looking at the program and at the list of those registered at our meeting here today, that there are many from government; from industry, both shippers and freight users; and from the academic community.

The workshop is dealing with a very timely subject, one that we have identified in our work on the committee as especially important in planning for the future transportation needs of the country. I am confident that the outstanding group of speakers and panelists will add substantially to the body of knowledge that deals with freight demand forecasting.

As many of you know, Dr. Jim Nelson, who is a member of our committee, has been the chairman for this demand workshop, and he had planned to be here today to chair the workshop, but unfortunately he was taken ill, and while he is recovering well, was not able to be here. So I have asked Dr. Donald Berry, also a member of our committee and Professor of Civil Engineering at Northwestern University, who has been intimately involved with all of our demand work from the start, to take Jim's place as chairman of the plenary sessions.

KEYNOTE ADDRESS

Alan A. Butchman
Deputy Secretary of Transportation
U.S. Department of Transportation

It certainly is a pleasure to be here with you this morning, and I am appreciative of the fact that I can start out by addressing you. I was very fortunate to be in Woods Hole last summer with many of the people here this morning. It was a very delightful session, both the setting and the substance. I am sure, even though we have a nice day starting off this morning, that many of you wish we could be back at Woods Hole today.

I hope I am going to be able to spend a few minutes with you this morning without having the telephone ring. Secretary Adams has been out of the country for the past 2 weeks; I have been doubling up in his absence. Friday as he was coming home, he called from the plane from Gander; although I had written him a 10-page memorandum on what happened during the 2 weeks that he was away. I think it will take him about 15 minutes to get through that, and then he is going to start looking for me. So I hope I will be able to get through this talk with you this morning.

Freight transportation has often been referred to as the invisible service, something that most people, as long as the service is being provided, really do not pay a great deal of attention to. Certainly the traffic manager is concerned about it, the freight forwarder is concerned about it, and you and I are very much concerned about it because we are the ones who must do the thinking and the planning on a long lead-time basis.

This morning I would like to share some thoughts on where we are in transportation, the "state of the art"--so to speak--and some of the major factors that I see impacting on the decisions you are going to be making as a result of your workshop. Let me say, first, however, that this situation reminds me of a short story I would like to share. There was a clergyman who had a particularly interesting donkey, one that would start only if you said, "Thank the Lord," and would stop only if you said, "Amen." Well, one very bright, sunny day, the clergyman set out on his donkey, and as he traveled he fell into deep contemplative ecclesiastical thought. Suddenly he was startled to realize that he was on a collision course with a very steep cliff. He was so alarmed that he found himself shouting "Stop" and "Whoa" instead of "Amen." In fact, he got right to the edge before he remembered to say, "Amen." The donkey obediently came to an abrupt halt right on the edge of the

precipice. With a great sigh of relief, the clergyman took off his hat, wiped his perspiring brow, and said, "Thank the Lord." You call that jumping into the unknown, I suppose.

I think it is fair to say that our transportation system today is in a state of maturity. As far as the railroads are concerned, we had a larger route structure 50 years ago than we do today. We had approximately 250,000 miles of track at that point; we have something less than 200,000 miles today.

As far as our highway system is concerned, the interstate network is very close to being completed; it is now in excess of 90 percent completed. We have a piece of legislation before the Congress now--a bill that is being met with varying degrees of enthusiasm--which has, as one of its goals, the early completion of the interstate system, and we are hopeful that we are going to be able to get that passed in this session.

Certainly, the waterway system is complete. The airline system, although in a state of some flux, is mature, and I doubt that we are going to see any more than a couple of hub airports built within the foreseeable future.

It is rather interesting to see that, even though this system was built pretty much on a piecemeal basis, it works as well as it does. A lot of it was developed without a great deal of coordination between the parts. But it has worked, and it has worked remarkably well.

However, right now we are in a time of transition. Our capacity has expanded. We have a mature system. But in the past, if we have had a problem, or if we have needed something, basically what we have done is just add to the system. I really seriously question whether or not we are going to be able to do that in the future as we have done it in the past.

I think we have to turn our attention at this point to making the system work more efficiently and more effectively. And, of course, underlying that is going to be our ability to forecast demand, and that is one of the things that you are going to be turning your attention to this morning, and for the next day or so at your conference. But there are several factors that have a very major impact on our ability to forecast the demand of what our freight system is going to need, and this morning I would like to touch very briefly on those as I see them.

Certainly, one thing is going to be cost. There is a substantial need for recapitalization of the system. At the top of our list--and I see my good friend Bill Smith in the back there, and we have conversations periodically about one segment of the railroad industry through the U.S. Railway Association (USRA) Board that we both serve on--ConRail in the northeastern part of the country has had a very difficult time and has not measured up to where we hoped it would be by this time. We are monitoring that system very carefully.

As recently as 2 or 3 weeks ago, we had a meeting with the President, precisely on the state of the railroads and what is going to be needed. I must say the President is extraordinarily concerned about this particular item. We happened to be seeing him on what we call a "spring preview process." There were probably only about a dozen or so issues that

were identified on a government-wide basis for discussion with the President at this first part of the Fiscal Year 1980 budget cycle. And the only item that we were discussing with the President at that point was the status of the railroad industry in general, and some of the things that we see are needed, and the directions we are taking.

As I mentioned a moment ago, the interstate system has to be completed. As I am sure all of you know, when the system was started two or three decades ago, in the 1950's, with enactment of the National Defense Transportation Act, the agreement was that federal dollars would be spent to build the interstate system, and the states would provide the maintenance. It is easy to see now that the states are not able to maintain the system. What we feel we have to do now is to hasten interstate completion so we can turn our attention to its maintenance. There is a very great need in that area.

I would be remiss if I didn't also mention the bridge repair situation that has become difficult in many parts of the country. There is a good deal that needs to be done in that area. Then, when we look to our aviation industry, the fleet is getting old. It is noisy. It is much less fuel-efficient than it should be. Something has to be done there. I think this should give you at least a broad-brush treatment of the need for capital in the industry. Certainly there is a need for both private and public dollars, and how that mix is going to be cut up is something that we will only see as we evolve.

Turning to energy, I was trying to see how I would treat this next part, and I finally concluded there were two major issues: first, the conservation of, and second, the transportation of energy. These items bring up several things that are of interest to this group today.

We have to make better use of our freight capacity and do a more effective job of integrating our transportation modes. There is one thing that I think is very interesting, and that exemplifies what we have to do. Just a week ago on the fifth of June, the Milwaukee Railroad started an express freight service between Chicago and St. Paul. They are using 32 trains a week that carry piggyback trailers and containers between intermodal terminals in those two areas. They make that 800-mile round trip in 24 hours with a 10-hour time each way, and a couple of hours turnaround.

As far as the transportation of energy resources is concerned, we have a lot of action in that area. Certainly, whatever we do is going to have an impact on several of the modes, and that is something that the Department of Transportation is extremely concerned about. I guess we started very shortly after we came to the department a year ago, with the creation of a Coal Roads Task Force that looked at what was going to happen in a number of different areas as we started moving more coal, and as we started shifting from a great utilization of oil into a greater utilization of coal.

We also have to look at pipelines when we consider this particular problem. We have a vast network out there. There are approximately 440,000 miles of intercity pipeline representing an investment of $21 billion. It is quite safe, efficient, and an environmentally acceptable way of moving some of the energy resources that we are going

to be using more and more in the coming years. We are getting increased attention paid to pipelines because, I am sure, of the Alaskan oil situation, the proposed natural gas line, and certainly the question of coal slurry being moved by pipeline.

We are paying particular attention to this question of coal slurry pipelines, because you can imagine the impact that this can have upon the railroad industry.

As far as the legislation before the Congress is concerned, it does provide for certification by the Department of Energy, but with concurrence by the Department of the Interior and the Department of Transportation. Basically, the posture that we have taken on coal slurry pipelines is that we are going to look at each particular situation as it arises and make a judgment on that basis, on the merits in that particular instance, as opposed to trying to have a general overall viewpoint.

We are very, very deeply involved at present with the Department of Energy, looking at the potential requirements for the transportation of energy between now and 1985 and even beyond. Some of the things that we are looking at in that study are possible bottlenecks by regions and the effects of changing energy traffic as we shift from oil to coal. Our target date for recommendations based on our task force effort is March 1979.

Two other things that we have to keep very much in mind when considering our freight transportation picture are environmental protection and safety. And I would use two examples to highlight these concerns. In the winter of 1976 and 1977, as I am sure you will recall, we had a host of tanker incidents off the coast of the United States. In fact, we had 17 incidents where varying degrees of oil were spilled. This led to a series of Presidential initiatives in March 1977, one of which involved tanker construction safety. As a result, an international meeting was scheduled by the International Marine Consultative Organization (IMCO), one of the United Nations (UN) organizations. I use this as an example because it is something that I spent a good deal of time in the past year working on as I led the delegation to these talks. We successfully completed an upgrading of the construction standards for oil tankers in February. But something that is interesting when you look at the problem and this particular part of the solution is that approximately 85 percent of the oil that is spilled in our oceans is a result of human error. The construction techniques or construction improvements that you can make attack only 15 percent of that spillage, and it is a very, very costly 15 percent.

I know that one of our common concerns in all of these areas is the problem of inflation. The demand on our dollar resources is intense, and we cannot make investments--or take costly actions--without seriously considering what we are getting for our money or how we can do the job more effectively or for less money.

Along the lines of safety and environmental protection, just this past winter we started having a large number of railroad derailments, tank car incidents, and toxic materials being released. I thought to myself, "My goodness, we are now not going to have happen in the

railroad industry what happened in the tanker industry, are we?" And yet to a degree, I suppose we did.

If you look at the number of derailments that we have in any year, 7,000 or 8,000 of them, and if you look at the number of those that involve hazardous substances, probably 500 a year, you conclude that neither figure is acceptable. Certainly the railroads have their problems. We have been having trouble with the roadbeds and tracks, and it is no wonder that there have been derailments. But it is a very serious problem, and, as our society requires the use of even more toxic materials, we are going to have to pay a great deal of attention to our ability to transport these materials safely and effectively. This, I am sure, is one of the things that is going to be examined carefully by your task force.

This morning what I really have been trying to do is to outline some of the difficulties that we see within the transportation industry--some of the concerns that have to be addressed as you look at our freight system of today--and try to determine what we are going to have as a freight system for tomorrow.

There is a great deal of information that is needed. There are a lot of imponderables out there. A lot of the things that we have raised are going to be treated by your group. I look forward very much to seeing what the report is that you come up with. Ray and Don, I want to thank you very much for having me down here this morning. It was a pleasure to be with you, and I wish you all the success over the next couple of days. Thank you.

PLENARY SESSION

INTRODUCTION

Donald S. Berry
Walter P. Murphy Professor
of Civil Engineering
Northwestern University

To begin our plenary session, I want to describe the workshop objectives. First, we hope to consider the overall or aggregate demand for freight transportation, and also the demand for several of the major freight commodities. We then will look at the estimates for growth in freight demand, taking into account possible alternative ways this country may be developing in the future in terms of problems with energy, productivity, life-style, and other important issues.

As a second objective, we hope to identify the types of research that will be needed to bring about improvement in forecasting techniques so that, knowing some of the aspects of the demand, the Department of Transportation and other departments will be able to devise better policies for the different modes for financing, for improvements to technology, and for better institutional arrangements.

TRANSPORTATION DEMAND--
AGGREGATE AND MAJOR FREIGHT CATEGORY
DEMAND ESTIMATION

Lawrence R. Klein
Benjamin Franklin Professor
University of Pennsylvania
and
Colin J. Loxley
Wharton Econometric Forecasting Associates

The presentation that I want to put forward is in two parts. One part deals with general economy modeling and the way transportation modeling would fit in with general economy modeling. The second deals with modeling the transportation sector as such.

This presentation has two points of interest. One is methodological: That is, how do we model the demand for transportation? And secondly, we are interested in some substantive results dealing with the outlook for the rest of the century essentially on both the national economy background and the freight sector in it.

Figure 1 shows a block diagram of the modeling structure of this system. What I am going to focus on is the top block in that figure, the Wharton Annual Model, which produces output and prices by sector. My associate, Dr. Colin Loxley, will describe the way the transportation model interacts with this model of the economy as a whole.

The purpose for having the top block is to show what the general economic environment is in which transportation is going to have to function for the next two or three decades; and, indeed, the previous speaker has talked about the inflation problem, or the output or demand problem. There is, as well, going to be a problem of relative prices, costs of energy, or costs of transport versus costs of manufacturing. These all have to be put together in terms of some kind of consistent framework, and that is why we go to the model.

The Wharton Annual Model, as we use it for this particular purpose, is a combination of an input-output model, and what we would call, in our own language and parlance, "an econometric model of the system as a whole that deals with demand and income generation." That is, it deals with demand by households and businesses, government and foreigners; it deals with payment of wages, profits, and interest costs, and it deals with determination of market prices, interest rates, wage rates, etc. It is a picture of the economy as a whole.

Having an input-output component means that we have estimates--and these are not true pictures, these are forecasts or estimates--of output across the whole economy. Essentially we have estimates of output in

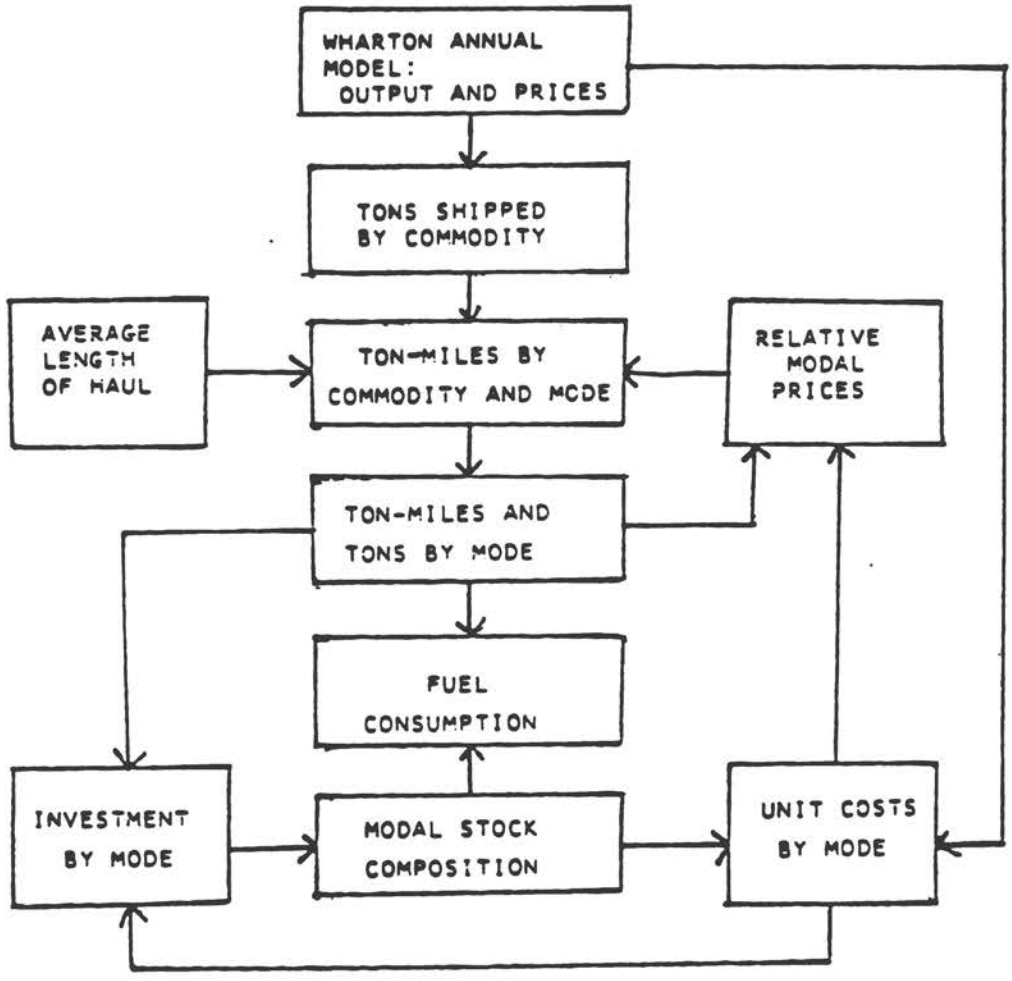


FIGURE 1 The structure of freight haulage in the Wharton Transportation Model. SOURCE: R. Epstein, *et al.* The Demand for Transportation. Wharton EFA, Inc., June 1978.

what would be called the two-digit manufacturing industries, although, in principle, one could go to more detail; we have estimates of the energy sectors, that is, the delivery of energy or conversion of fuel to energy; and finally, we have the trade and distribution sector in which transport functions.

There are two kinds of research strategies that one can follow in this sort of modeling. One can have a very large model, perhaps of 200 or 300, or in some cases, even 500 sectors, but then if one has such a large detailed model of intersectoral flow, one must have a very big model of demand and income generation to go with it.

On the other hand, if we opt for a more compact model of the inter-industry structure--in this case, some 50 to 60 sectors in all--then one can get by with a more manageable modeling of the rest of the economy. When we put it all together, it is a 1,000 equation system. And that is a lot of managing--data management, equation management, forecast scenario management, etc.--but when we put it all together, transportation comes out with a very rough picture. Transportation enters in essentially an unsatisfactory way; it enters as a transportation margin. Essentially if you have the flow of goods through the economy, you would have everything going into transportation at some point, and then everything coming out of transportation. It isn't modeled in that detail; only the transport margin of the total delivery cost is modeled. This gives an unsatisfactory or superficial picture of the transportation sector as such.

For that reason, and for reasons of detail, we don't want to use such a big system at the initial stages. For reasons of detail, we model this problem in a hierarchical mode, and we model transport as a satellite system; that is, a satellite system that my colleague, Dr. Loxley, is going to talk about, that has tons and ton-miles by mode of transport, by type of commodity, and pricing by type of transport. This is something we do, not only for transportation; we maintain energy models. We maintain models of specific industries, and we maintain the model of the system as a whole.

The general procedure would be, first, to make a projection, a scenario, or a forecast, depending on the particular objective in mind, for the economy as a whole; use the output of that system as input in the satellite system; and then analyze the properties of the satellite system. One could stop the process there; however, in principle, we are set up for an iterative procedure in which one would first have to make some assumptions about transportation, then get a picture of the economy as a whole, then make specific analyses of the transport sector in a satellite mode, and then ask if transportation, as determined in the satellite, is consistent with transportation as determined in the model of the economy as a whole. If there is a difference, one could revise the transport rows and columns of an input-output table on the basis of the output of the satellite system and reiterate the process and continue until we get convergence. Convergence would mean the transport magnitudes as determined in the satellite system are consistent with those in the box at the top of Figure 1.

That is the general procedure that can be followed, and we are going to describe two kinds of solutions that go along these lines. One solution would be a baseline solution that would be our standard baseline projection to the end of the century. In principle, one could cut short or extrapolate further. The other is a scenario analysis in which it is assumed that energy prices have risen more rapidly.

Now, in the particular scenarios or solutions studied, we assumed, for the baseline case, that crude oil import prices will rise by 5-1/2 percent a year. This is a year of no change, and we assume very roughly that crude oil is indexed afterward to the world inflation rate. That obviously tips our hand as to our assumption about world inflation going on, not necessarily in any one year, but on average for the rest of the century at about 5-1/2 percent. And our index of inflation from that point of view has been set by what we feel the inflationary charges will be to OPEC nations from the suppliers of materials. Basically, that would mean that industrial prices from the OECD region would grow at about 5-1/2 percent long term, and OPEC nations would index oil to that.

That is simply an assumption, and, indeed, for another assumption we have raised it to a 12-1/2 percent oil price scenario, which by compound interest is a very rough magnitude, a very severe magnitude, in the sense that it places a lot of pressure on the oil-consuming countries to have to pay 12-1/2 percent a year. This is simply an example of what could happen.

In principle, through such systems analysis, one could analyze not only a price change, one could analyze an embargo, a strike, or one could analyze problems of meeting a grain failure throughout the world in getting grain shipped from the fields to the ports--indeed transported throughout the world.

This is a national model and not an international model. The international assumptions, such as the oil price assumption, are made as data inputs to the system, and then the national interindustry dependence of one sector or another is modeled.

Let me call your attention to some of the general aspects of Table 1. It shows something about the kind of economic environment that we are talking about in this case.

The top item gives one of the clues to the kind of environment we are talking about. It shows that output as measured by the GNP grew at just under 4 percent from 1957 to 1973. The number is 3.8 percent, and in general up to 1973 we say that the American economy was about a 4 percent growth economy since the end of World War II. Since the beginning of this century, it has not been that high, but since the end of World War II it has been roughly a 4 percent economy.

One of the striking results, and one that is not at all unusual or unfamiliar, is that for the rest of this century the general supposition is that we will grow more slowly. From 1973 forward, the general assumption is that production will grow at about 3 percent in the United States. That may not seem like a big change, but it is a very major change; again relying on the laws of compound interest, as you shift from a 4 percent economy to a 3 percent economy, there is a very serious change.

TABLE 1 Output and Tons Shipped--Growth Rates

	Historical, 1957-73		Projected, 1973-95	
Sector	Output (%)	Tons (%)	Output (%)	Tons (&)
GNP	3.8	2.4 (Total)	3.0	3.0 (Total)
Manufacturing, minerals, and agriculture	3.5	2.4 (Total)	3.3	3.0 (Total)
All manufacturing	4.0	3.6	3.3	3.1
Agriculture	1.0	0.8	2.3	0.5
Metalic minerals	1.5	-0.7	6.4	1.9
Coal	0.6	-0.3	3.5	4.1
Crude petroleum and gas	1.8	1.8	4.5	3.5
Nonmetalic minerals	2.8	0.5	3.0	2.9
Food	2.5	3.2	3.3	4.0
Tobacco	2.6	3.4	3.1	5.4
Textiles	5.0	5.4	2.7	2.2
Apparel	4.0	8.5	3.3	7.4
Lumber	4.6	2.5	3.6	1.6
Furniture	3.8	6.1	3.3	5.1
Paper	5.0	3.5	3.2	2.7
Chemicals	6.4	6.3	3.3	3.7
Petroleum refined	4.0	4.0	3.8	4.2
Rubber	7.4	5.4	3.1	2.2
Leather	0.9	6.1	2.8	1.2
Stone, clay, and glass	3.2	4.7	3.2	2.8
Primary metal products	1.1	0.9	1.8	1.8
Fabricated metal products	4.0	1.5	2.7	2.8
Nonelectric machinery	4.1	2.8	3.2	3.2
Electric machinery	7.6	4.1	3.8	3.0
Motor vehicles	5.3	3.9	3.6	2.9
Other transportation and ordnance	0.9	-0.6	3.3	4.4

SOURCE: R. Epstein, *et al.* The Demand for Transportation. Wharton EFA, Inc., June 1978.

That is one aspect of the environment in which we are working. If I included something about inflation here, I would say that perhaps the general level of inflation from the end of World War II to the present has been around 4 percent, maybe a little bit less at certain periods, and the general picture for the rest of the century is not very far from that assumption that I gave you about oil prices being indexed; it is about 5 percent, or between 5 and 6 percent.

That is a rather complicated explanation of why we have come to this scenario of a baseline for the rest of the century as one of slower growth and higher inflation, and it is associated with high energy costs. It is also associated with protecting the value of the dollar, keeping money markets in relative stability, and also not letting unemployment get too high or too low, taking account of the growth of population and labor force. It is a highly integrated and rounded calculation, but this is the output of that calculation that serves as input to the transportation model.

If you will look down the column of Table 1, you will see the different row of entries as growth rates for different sectors of the economy. In the left columns they are growth rates historically, and in the right columns they are growth rates projected by the input-output system, then translated into tonnage and tonnage carried by the transportation model.

That is the model that is described in very crude form in Figure 2 as to general equation structure. This model is really managed by Dr. Loxley, who will explain the finer structure of that model, together with the scenario results between this baseline calculation and the calculation with higher energy prices as it impacts on the transport sector. Dr. Loxley.

(Dr. Loxley began his portion of the presentation by referring back to Figure 1.)

In the modeling approach, we are talking about an aggregate transportation system. The primary levels of detail in the system are by commodity group, where we have a total of 25 commodities distinguished, and by mode of transportation where, depending upon the particular component, we may look at rail, truck, water, air, and pipelines.

There is also, in addition to the freight side of the model, a fully specified passenger transportation analysis also, so that we can, in fact, look at the whole transportation picture.

With reference to Figure 1, we take industrial output as indicating the linkage to tons shipped by commodity group, so that economic activity from the annual model directly drives shipments within each commodity. Tons shipped by commodity are then translated into ton-miles by commodity and mode by a modal share analysis. The primary determinants in this system of the modal share analysis are relative modal prices. This is very much a long-run equilibrium type of system. In the long run, therefore, we expect prices for different modes to be at different levels with respect to one another, reflecting different service characteristics of those modes. Over time, however, if we see changes in the relationship between relative prices, we would expect to see one of two things. We would either expect to see a shift between

TONS = f (OUTPUT)

MODAL SHARE = f (RELATIVE PRICES,
SERVICE CHARACTERISTICS)

NON-FUEL COSTS = f (TON-MILES, LOAD FACTOR)

FUEL COST = f (TON-MILES, RELATIVE FUEL COST PER MILE,
STOCK OF EQUIPMENT)

REVENUES = f (COSTS, COMPETITOR'S PRICES)

INVESTMENT = f (TON-MILES, COSTS, STOCK OF EQUIPMENT)

FIGURE 2 Summary of key relationships. SOURCE: R. Epstein, *et al.* The Demand for Transportation. Wharton EFA, Inc., June 1978.

modes or, for one reason or another, we would expect to see one mode having a greater comparative advantage because of some service characteristic. It might be the time involved in shipments; it might be reliability of delivery; it might be safety, whether the shipments are damaged or not.

The relative modal prices, which in turn determine how much is shipped by a particular mode, are themselves determined by unit costs; that is, average costs per ton-mile. Here we look at "real" costs, that is, in terms of 1972 dollars. The costs by mode are, in turn, generated by the supply side of the model, so that we do have here a fully specified demand and supply system, although I would be the first to admit that some aspects of the supply side of the model require further development. I certainly would desire to implement this further development.

From ton-miles and ton-miles by mode, we estimate investment by mode--obviously, how many trucks, how many railroad cars we need, are very much affected by the amount of ton-miles shipped by that mode, in aggregate. Investment is determined by ton-miles but also is affected by unit cost. So the level of inflation, how much equipment costs, the level of fuel costs, etc., in turn, affect investment. Investment, being the marginal addition to the stock of equipment, affects the kind of equipment we have--how many diesel trucks, how many gasoline trucks, etc.

This is particularly important from the point of view of fuel consumption, which is therefore one of the outputs of the model, and which also has an impact on the costs.

Figure 2 attempts to depict, in significant form, the formal structure of the model. Here we have tons being a function of output. This is a primary specification. In many cases, the relationship between tons and output originating within a sector is extremely strong. In some instances we find that transportation shipments of a particular commodity are sensitive to output in more than one industry. It may be the producing industry and the consuming industry, which are both important in determining how much is shipped between them.

The modal shares, as I have indicated, are primarily a function of relative price. A major area that we would like to develop in the future is the question of measures of service characteristics which would be appropriate for this kind of modeling analysis. They are rather difficult to come by in terms of an annual aggregate model of this kind.

Nonfuel costs--this is in real terms--in 1972 dollars per ton-mile, are looked at in view of long-run prospects. As the activity in the particular mode increases, we would expect to see something resembling, perhaps, a U-shaped cost curve. Indeed, this is the approach that we followed. An additional factor, as well as activity, is load factor itself; how much the system is being utilized at present. If the system is currently underutilized, that implies that costs may tend to fall as we increase utilization.

Fuel cost is generated by a system looking at ton-miles, the relative fuel costs per mile, where there are indeed genuine options--for instance, perhaps between electricity or diesel or gasoline or diesel and the stock of equipment. This is one of the hardest areas to analyze, because the fuel cost for the fleet is, of course, different from the *a priori* fuel cost in terms of new investment.

Revenues--here we look at revenue per ton-mile, and this is very much an average revenue per ton-mile. This is what we look at as our measure of price for the particular mode. Here we look at revenues in terms of the cost markup hypothesis; presumably on average--and, of course, there will be many specific exceptions--but on average, one's revenues are presumably designed to cover one's costs, at least in normal business operation. Therefore, the rate at which one's revenues increase will be partly related to how much general inflation is going on and how it is affecting you, as well as one's competitive prices, so that the revenue for a particular mode would be sensitive to the revenue or prices charged by other modes.

Finally, let us consider the level of investment. Net investment in the stock, if we express it as a function of ton-miles, is a kind of accelerator hypothesis, dependent also on the costs of operation and the stock of equipment already in place. The more we have today relative to ton-miles being demanded, the less investment we need.

With that very brief introduction, let me describe some of the results of a very preliminary type of forecasting activity.

We have taken from the Wharton Annual Model a forecast that was actually made last year. Some of the cyclical patterns in the initial periods may be subject to change. The second thing that one should say is that we would want to look, particularly in the beginning, at the overall economy and transportation and the relationship between the two. I have divided the period into two parts to try to establish some kind of sense of where we have been and where we are going. Dr. Klein referred to this earlier; that we do anticipate somewhat of a shift from historical relationships.

I looked at the period 1957 to 1973. That is a peak-to-peak relationship, and, therefore, it is not obscured by the downturn that we have experienced in 1974 and 1975, and the recovery that is currently in process. So if we look at 1957 to 1973, we find that the gross national product grew over this period by 3.8 percent. However, there was a shift away from the industrial sectors--mining, agriculture, and manufacturing--the goods-producing sector had an annual average growth rate of 3-1/2 percent.

During this same period, we observed that ton-miles grew at a slower rate, on average by 2.8 percent. There was a net increase in the overall average length of haul, since tons grew by only 2.4 percent.

In our projection, we have a somewhat different economy. We have basically a 3 percent economy. It is made up in terms of something like a 1-1/2 percent per annum rate increase in the labor force and a 1-1/2 percent rate of increase in productivity. That twin set or propositions basically constrains our equilibrium rate of growth; in real terms it is put at 3 percent. But we do anticipate that the goods-production sectors of the economy will reverse their previous trend and grow at a more rapid rate than overall GNP. Agriculture, mining, and manufacturing should average just about 3.3 percent growth rate per year from now through 1995.

That is quite a reversal. We have seen increasing government and commercial activity over the past 15 years. We expect now to see a move toward a higher level of manufacturing output growth and a slower rate of

government and commercial activity growth. It is a higher investment economy, too, and this has particular implications for transportation.

As a result of these trends, we expect that ton-miles shipped should average about 3.1 percent, virtually the same as GNP growth, and slightly slower than the overall goods-producing sector's growth. Tons shipped, right in line are at a 3 percent per annum growth rate. We expect to see the transportation sector running at growth rates much more similar to the general economic growth rates right through 1995, than we have in the past.

Some of the reasons can be discerned in an initial way from Figure 3. The dotted line indicates growth rates of ton-miles from 1957 to 1995, and the solid gives growth rates of real GNP. We can see very clearly from this that, by and large, transportation tends to be more severely affected by recession than GNP itself. After all, GNP is much more aggregative; it is much more insulated from some of the severity of the shock. Government can increase expenditures, and that will show up directly in GNP. Perhaps not much of it will show up in the transportation sector.

Therefore we see in some of the recessions, 1957-58, 1961, 1967, and most spectacularly in 1974-75, that the ton-mile growth rate plummeted much more than GNP. This is very largely responsible, therefore, for the slower growth rate of transportation activity.

In the 1974-75 recession, for instance, manufacturing output fell by more than 6 percent in each year, while GNP fell only just over 1 percent. Given the sensitivity of transportation to manufacturing, the implication is clear.

We also have an increasing importance of manufacturing tonnage versus agriculture and mining. Historically, manufacturing output grew by 4 percent per year, while tons shipped in manufacturing grew 3.6 percent. In the forecast, manufacturing grows by 3.3 percent, and manufacturing tonnage now grows very consistently with overall tonnage at 3.1 percent.

In Table 1 the columns compare output originating from the annual model, both historically and projected, with tons shipped from the transportation model, historically and projected. There are many data problems, but nonetheless we can see that in many industries there are similarities in growth rates between these. In most instances the relationships between these are projected forward. We do expect, for instance, that coal will have much higher growth rates in terms of output and shipment. We expect to see crude petroleum and gas rising, although this may be a rather optimistic projection. We expect to see agriculture rising slightly more rapidly in terms of output, but not in terms of shipment.

Let me run rapidly through some of the other results that we have found.

Figure 4 shows the growth rates of coal tons shipped, and also, for an interesting comparison, crude oil shipments. Of course, coal is much more cyclical overall and particularly shows strong spikes in a recession or strike period.

Figure 5 depicts a modal comparison between truck and rail and pipeline. Modal split, as everyone here knows, has favored truck over

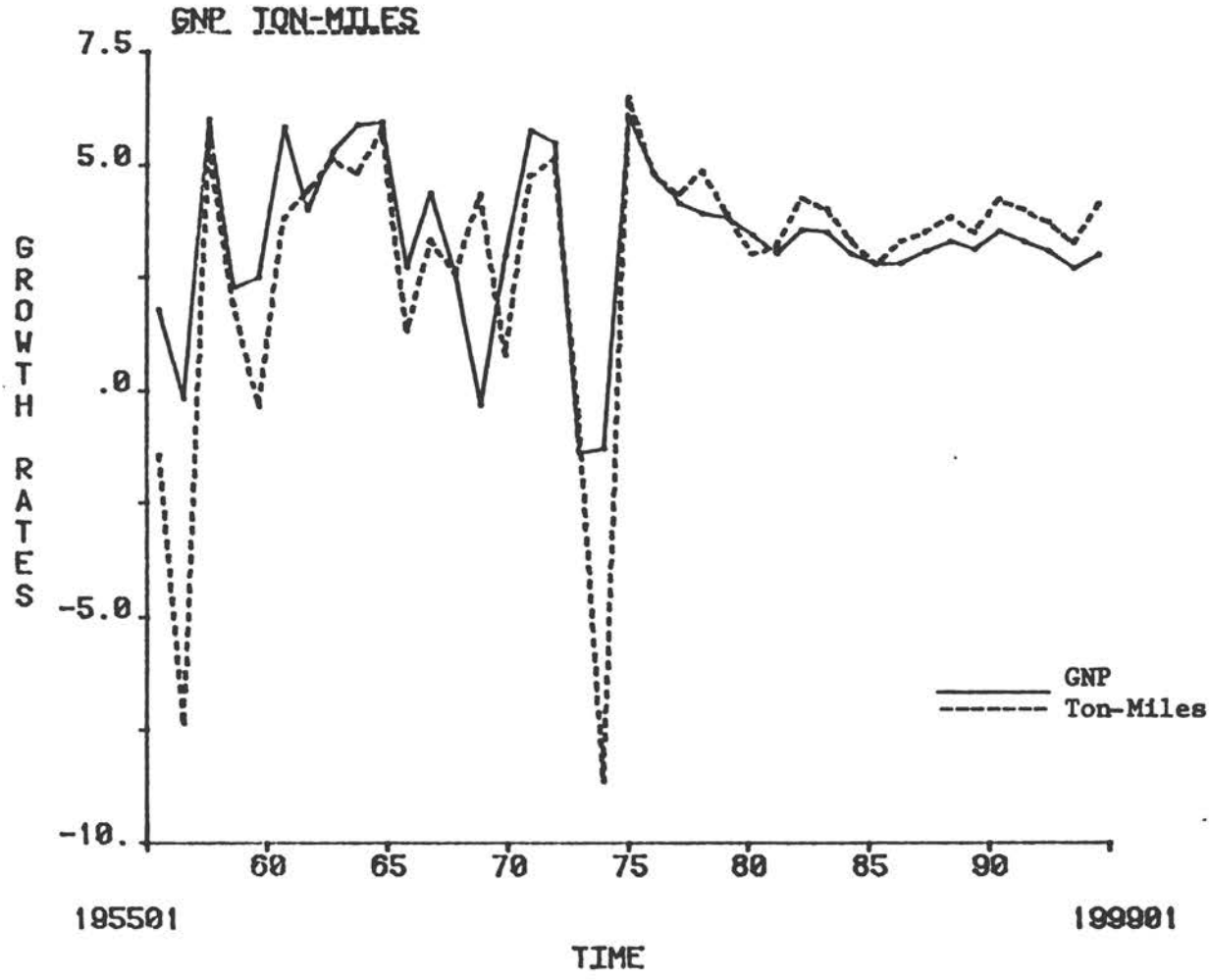


FIGURE 3 The economy and transportation growth rates, 1957-95.
SOURCE: R. Epstein, *et al.* The Demand for Transportation. Wharton EFA, Inc., June 1978.

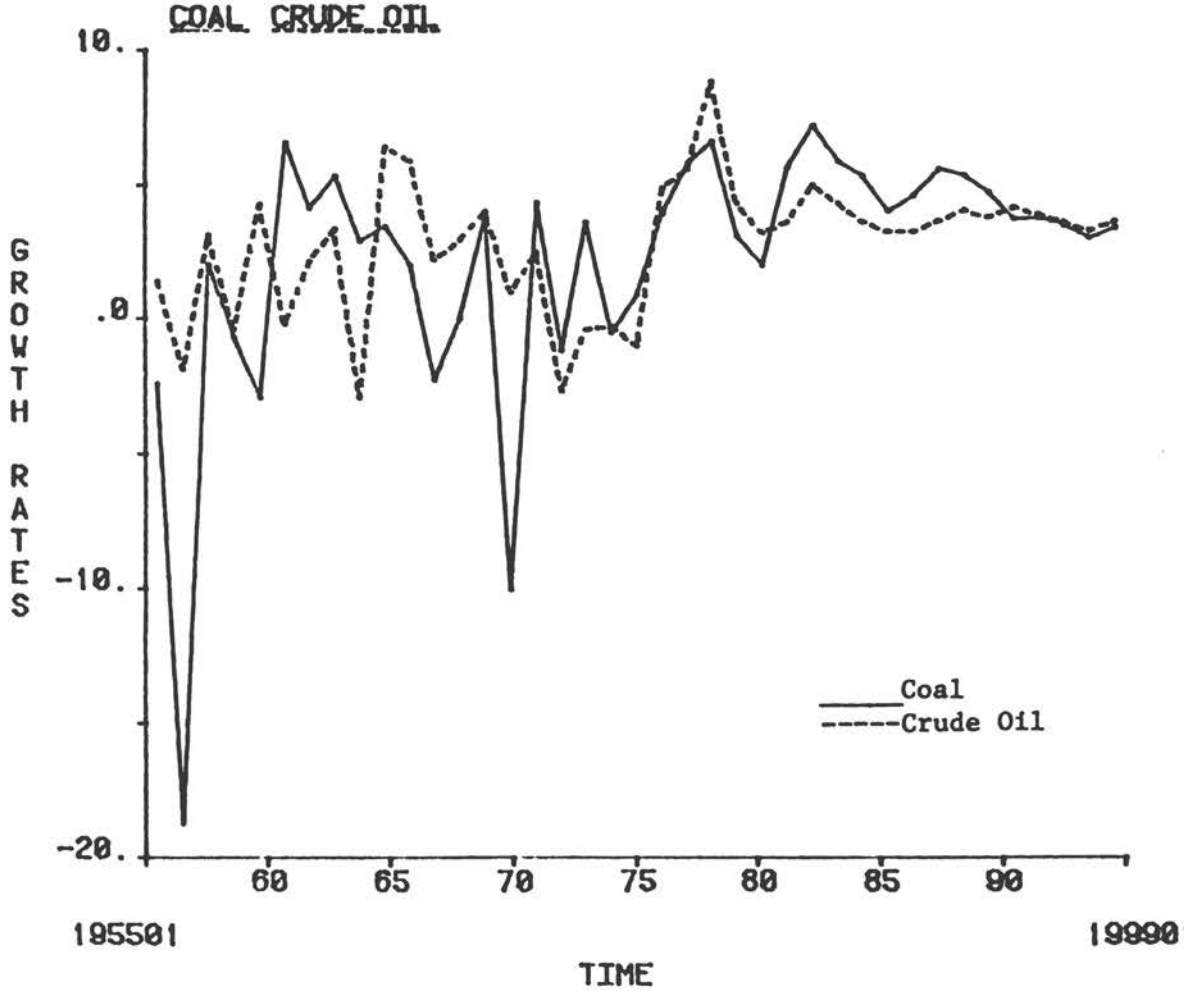


FIGURE 4 Tons shipped and growth rates, 1957-95. SOURCE: R. Epstein, *et al.* Wharton EFA, Inc., June 1978.

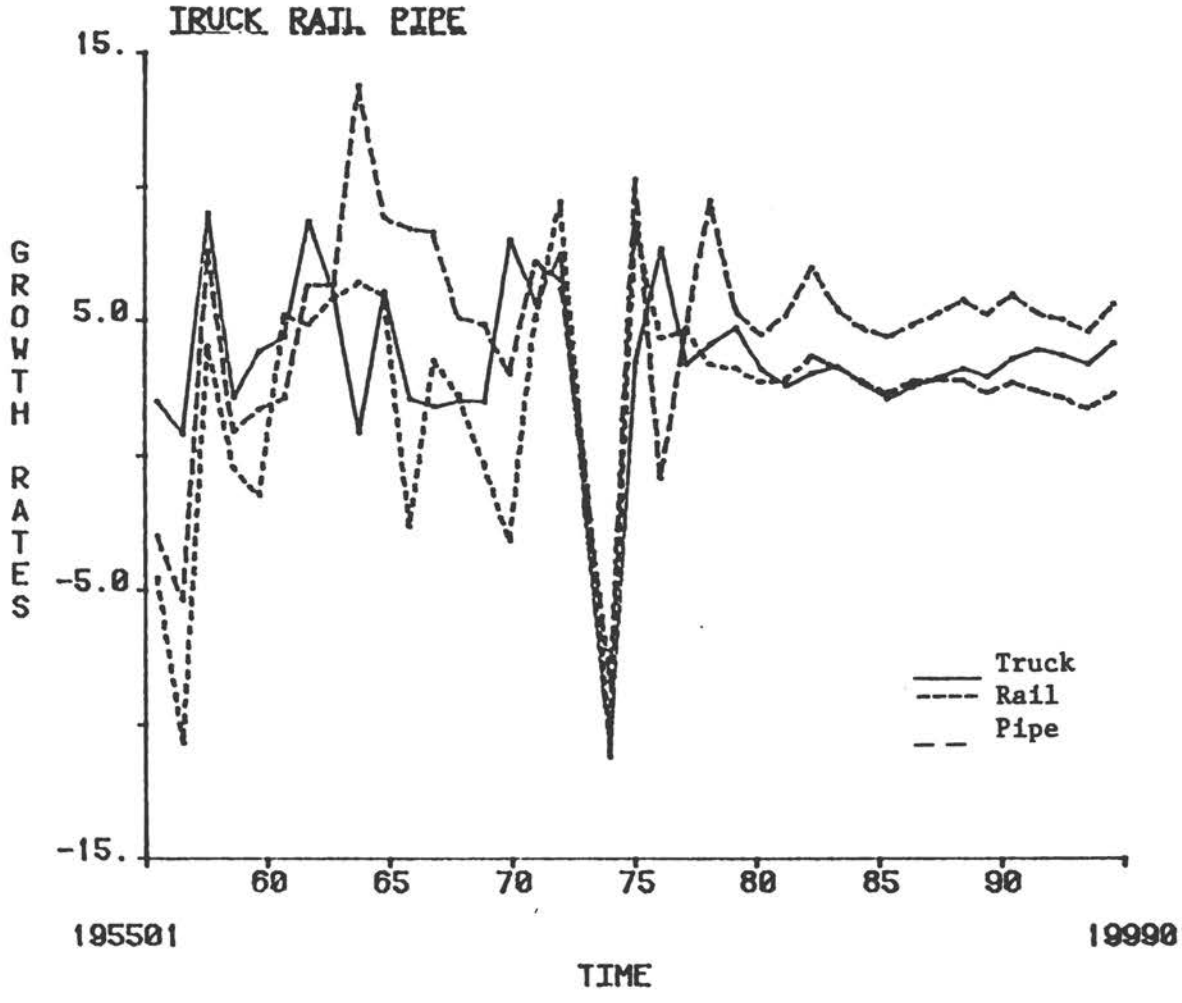


FIGURE 5 Ton-miles shipped and growth rates, 1957-95. SOURCE: R. Epstein, *et al.* The Demand for Transportation. Wharton EFA, Inc., June 1978.

the last 15 years or so; from 1957 to 1973 truck ton-miles grew at an estimated average rate of over 4 percent, while rail freight ton-miles grew at a rate of only 2 percent per annum. Pipeline ton-miles also grew very rapidly at a rate of 5 percent per annum.

Looking forward, we expect to see the following general trend by mode. Given an overall ton-miles projection, at a growth rate of just over 3 percent per annum, we would expect to see a growth rate for truck shipment of about 2.5 percent per annum; for rail, of 2.3 percent. Truck is significantly down; rail slightly up; pipelines are still growing strongly at 4.4 percent per annum; air is still growing strongly at almost 10 percent per annum, just slightly down from its 12 percent historical rate. Water is an area that I have problems with. Currently, we are showing a 3 percent growth rate of water shipments. This is up sharply from the historical trend of just under 1-1/2 percent per annum. Here I think we may be being too favorable to water shipments.

In terms of modal shares, we can see our going from about 40 percent rail in 1957 down to 35 percent in 1973, still continuing to decline to 30 percent of total ton-miles shipped in 1995. We expect to see trucks, having increased from 16 percent to over 20 percent, decline slightly to 18 percent by 1995. Pipelines' share of total ton-miles, having gone from about 14 percent to about 20 percent, is expected to continue to increase.

Water is the most difficult mode to deal with, because of the obvious geographical limitations; routes are well-defined and constrained. It is difficult to incorporate these constraints into this kind of aggregate model.

The curious fact is that, contrary to the impression one gets from the aggregate picture, relatively little of the modal shift is due to direct competition for shipment of an individual commodity. Most of the shift between modes can be traced directly to differential growth rates between industries and the shipping modes attached to those industries. For instance, much of the trucks' increase and relative gain are due to higher manufacturing growth. That is indicated on Table 1 with some allowance for increases in the average length of haul in the sectors. It is helped by a generally slight increase in the modal share of trucking in manufactured commodities.

For instance, if rail's modal share by each commodity group had been the same in 1973 as in 1957, the rate of growth of rail shipments would still have been only 2.3 percent versus 2 percent.

Looking at Figure 6, it was probably a mistake in retrospect to include the year 1974. It makes everything else look rather Lilliputian. These measures of average costs per ton-mile are in terms of 1972 dollars. Having risen by over 40 percent in 1974, largely as a result of fuel cost impacts, the truck average cost per ton-mile is expected to grow, in real terms, at just over 3 percent through 1995. In contrast, rail could have a significant comparative advantage, because we project only a 2 percent growth in average cost per ton-mile.

Historically, from 1957 to 1973, we have seen the truck cost per ton-mile in real terms fall by almost 2 percent a year, and rail fall at almost 1/2 of a percent a year.

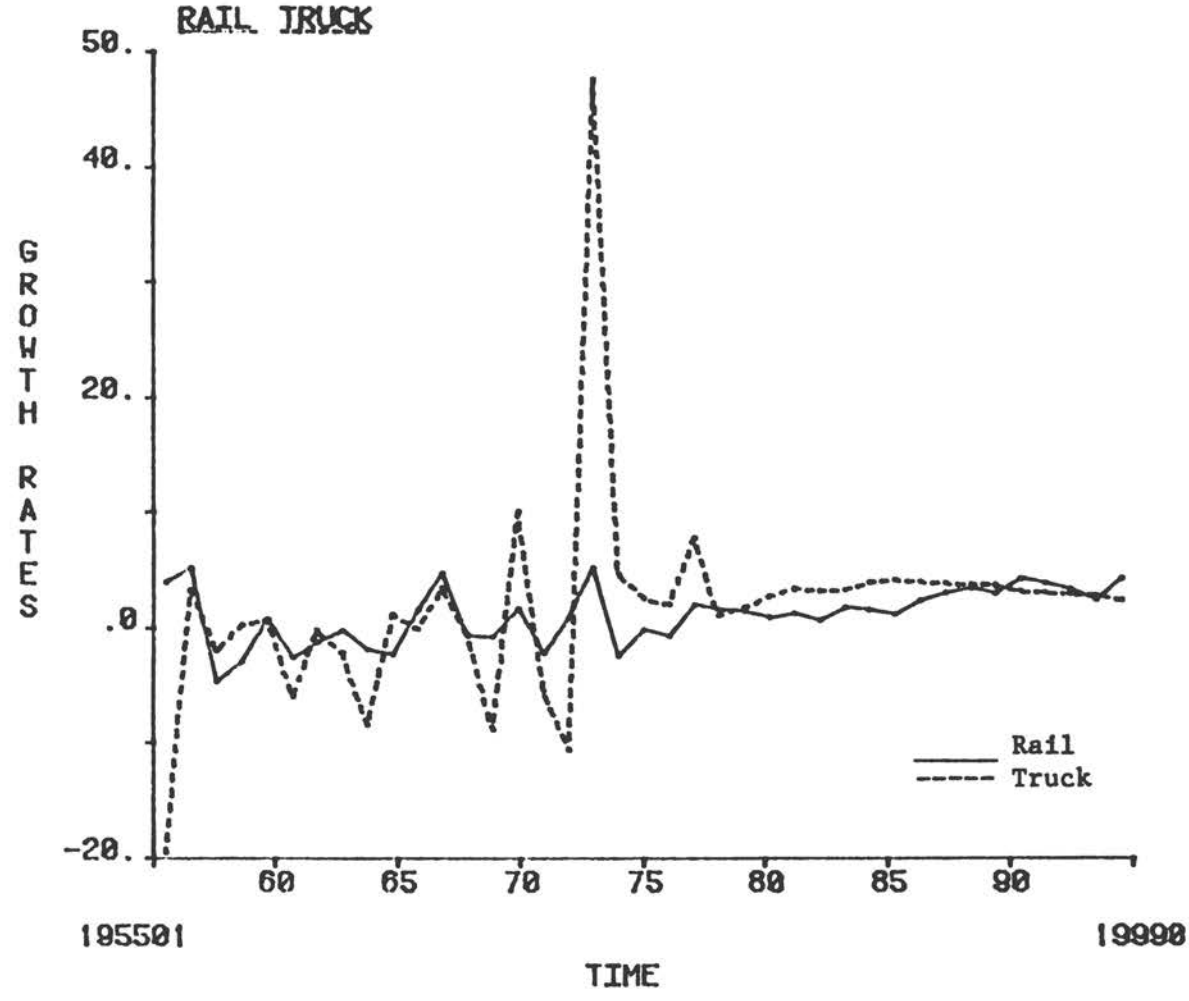


FIGURE 6 Average cost per ton-mile and growth rates, 1957-95. SOURCE: R. Epstein, *et al.* The Demand for Transportation. Wharton EFA, Inc., June 1978.

Figure 7 shows a comparison of the alternative scenario; that is, the higher energy cost scenario. We note that the GNP growth rate is reduced in every period; so the overall impact is quite significant. Again, considering the 1973 to 1995 period, we see a growth rate of 2.8 percent, as compared to 3 percent in the baseline. Since most of this reduction occurs in the 1980 to 1995 period, this is quite significant. Inflation is also somewhat higher, on average, from 1973 to 1995. We originally projected a growth rate of the implicit deflator at 5.9 percent. This has increased as a result of higher energy prices to 6.1 percent. The impact on specific energy items such as gasoline is, of course, much greater.

From 1973 to 1995 in the baseline case, we have an increase in gasoline prices of 8.1 percent. In the alternative case we have a growth rate of 11.2 percent, an increase in the rate of growth of more than 3 percent.

If we compare shipments in terms of the impacts on the transportation industry, we find that they are indeed quite different by modes. Here we have the total tons shipped. We have a slight increase in 1984, but otherwise growth rates are continuously lower. Total ton-miles grow at only 2.7 percent versus 3.1 percent in the baseline, so the reduction due to higher energy prices is estimated at .4 percentage point.

Figure 8 reflects truck ton-miles, and by positioning Figure 9 along side of Figure 8, one can compare truck and rail. The decline in truck ton-miles suggests that an average rate of growth of 2-1/2 percent would be cut to a 2 percent growth rate. So we have a reduction in the growth rate from 2.5 to 2 percent, which is a relative decline of over 20 percent in terms of the growth rate. Rail is somewhat less affected, as seen when the two figures are juxtaposed.

In Figure 10 the top solid line and the top dotted line are the scenario impacts on rail ton-miles shipped. One can see that, even in the alternative scenario with higher energy costs, the rate of growth of rail shipment still matches the original rate of growth of truck ton-mile shipments. We expect that higher energy costs will have a more severe effect on truck shipments than on rail.

DISCUSSION

DR. LOXLEY: The question is a very good one and relates to the projections of the primary commodities, particularly in the mining sector. We should consider the largest one first, and that, of course, is coal. In fact, we have projected a 3-1/3 percent rate of increase in output originating for coal. That is probably too low, based upon most of the current goals and objectives of the nation's energy plan. We, therefore, have tons shipped growing by 4 percent.

We recognize that represents a rather large reversal. We are, however, assuming that the supply will respond to the demand. If we are attempting to encourage consumption of coal, which seems to be present policy, as well as trying to reduce our use of imported oil, which also

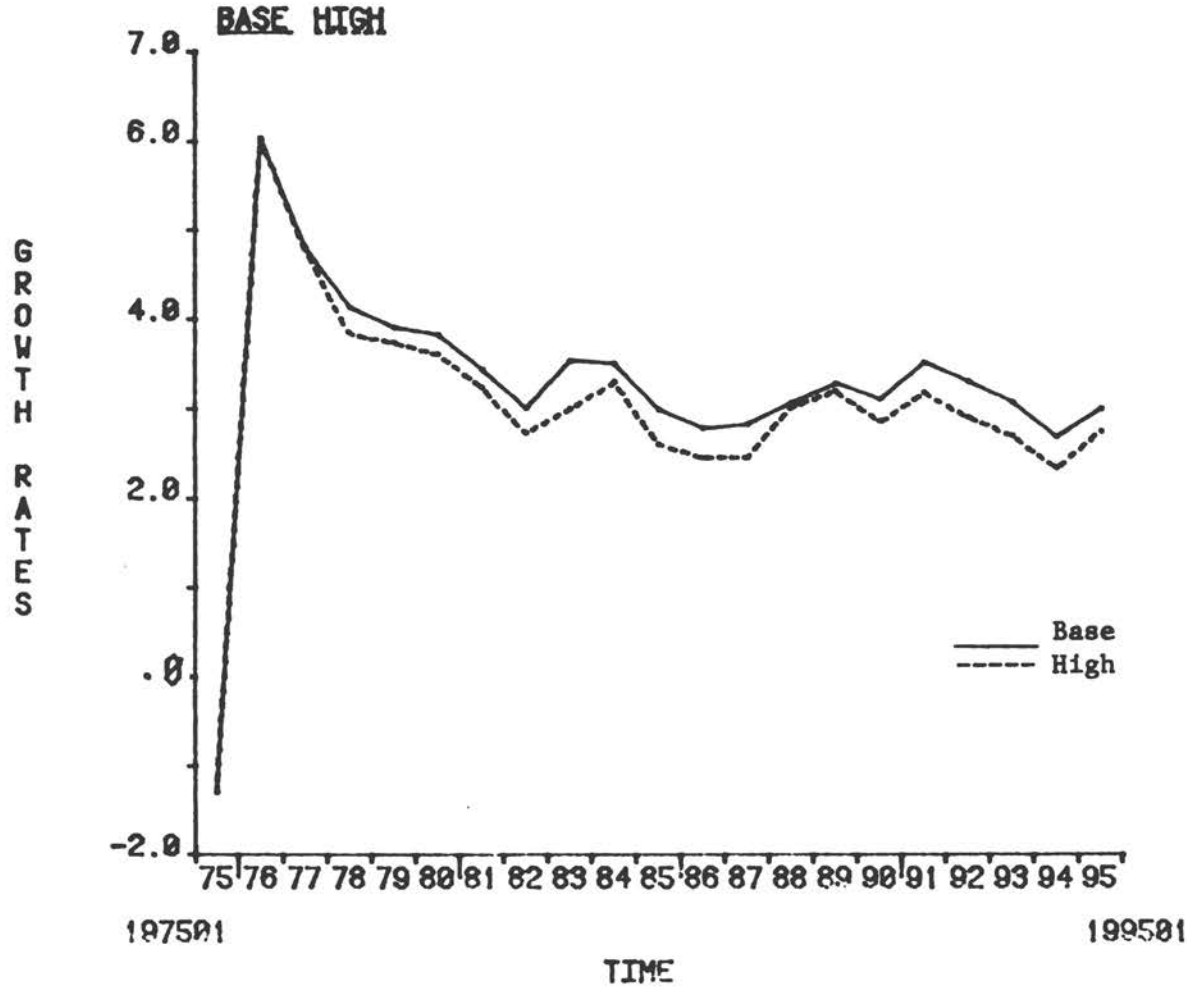


FIGURE 7 Gross National Product control vs. alternate growth rates, 1975-95. SOURCE: R. Epstein, *et al.* The Demand for Transportation. Wharton EFA, Inc., June 1978.

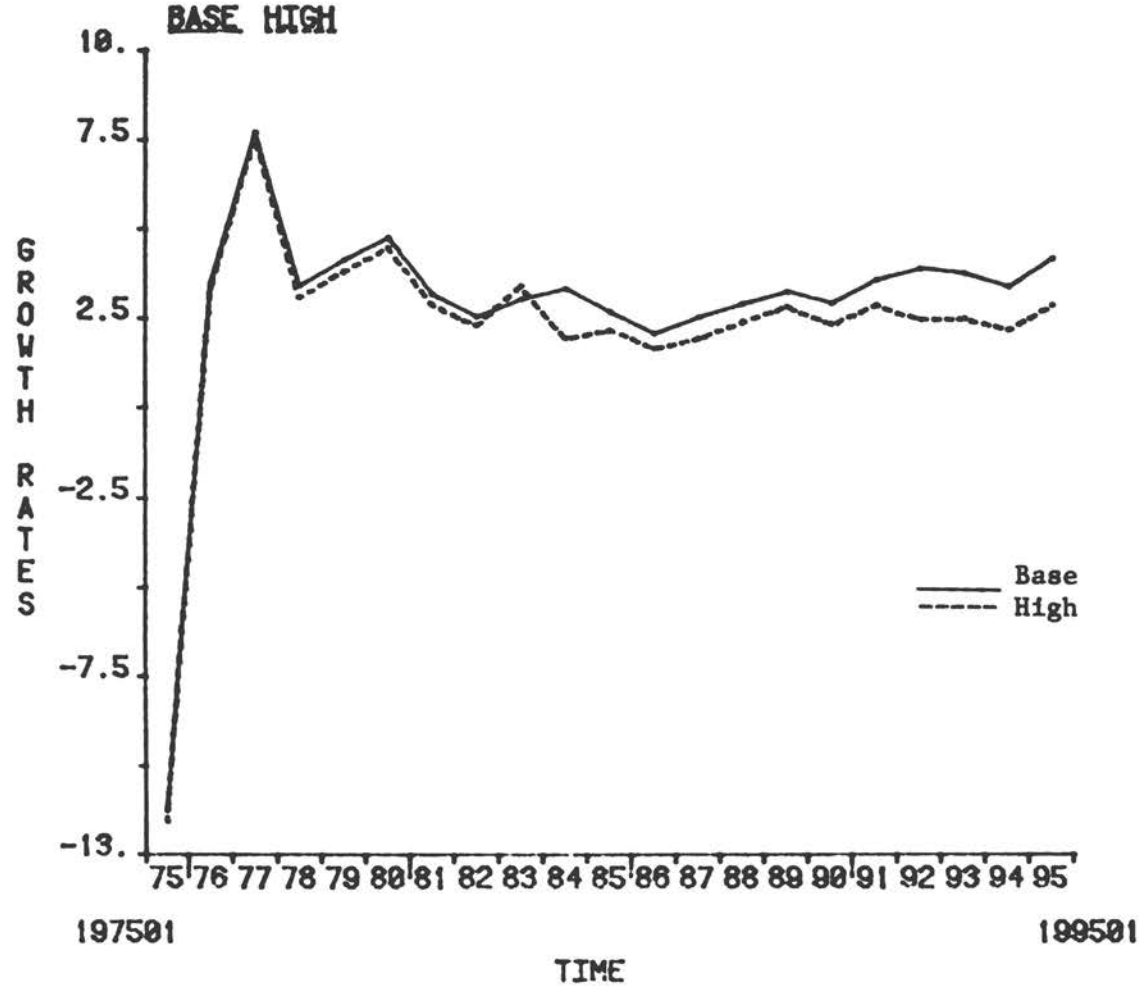


FIGURE 8 Truck ton-miles control vs. alternate growth rates, 1975-95. SOURCE: R. Epstein, *et al.* The Demand for Transportation. Wharton EFA, Inc., June 1978.

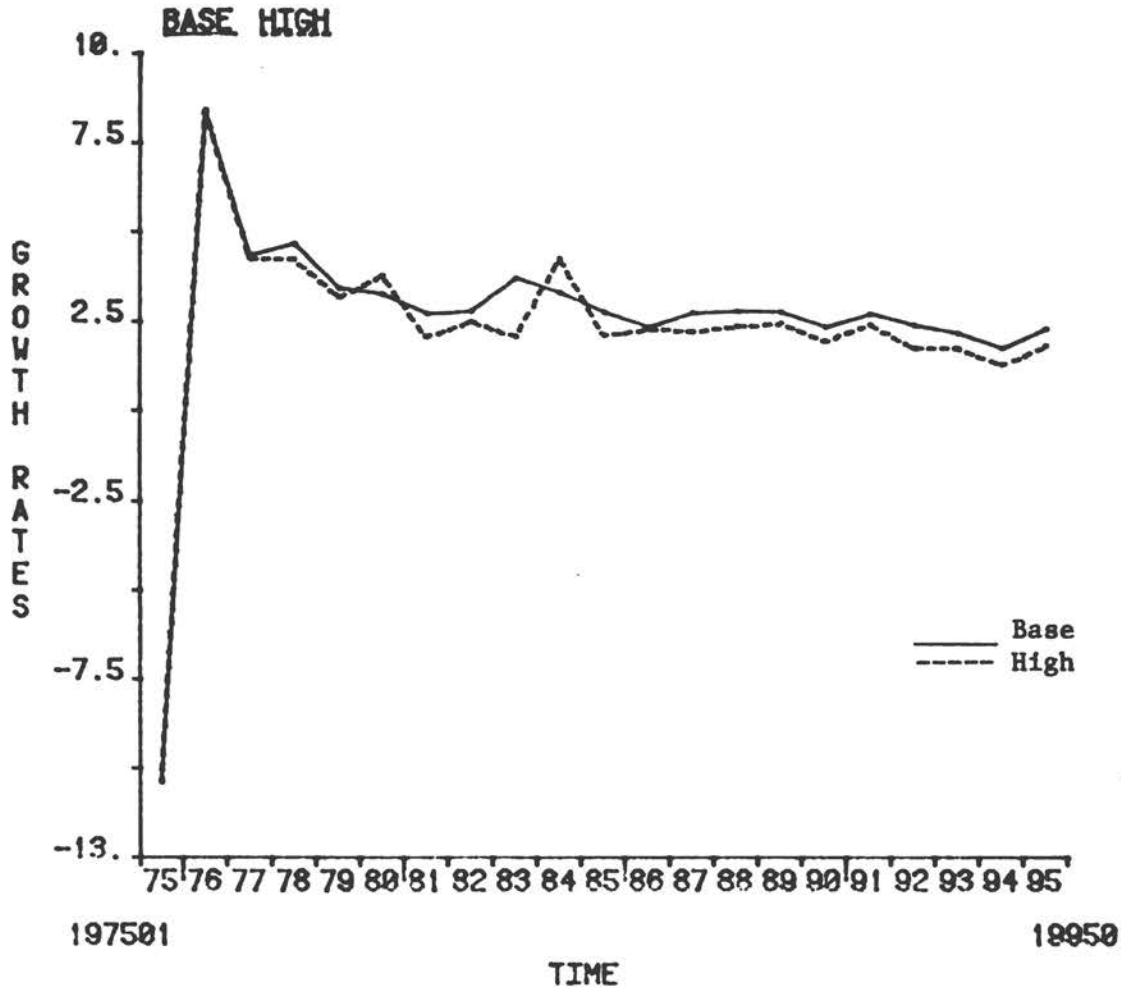


FIGURE 9 Rail ton-miles control vs. alternate growth rates, 1975-95. SOURCE: R. Epstein, *et al.* The Demand for Transportation, Wharton EFA, Inc., June 1978.

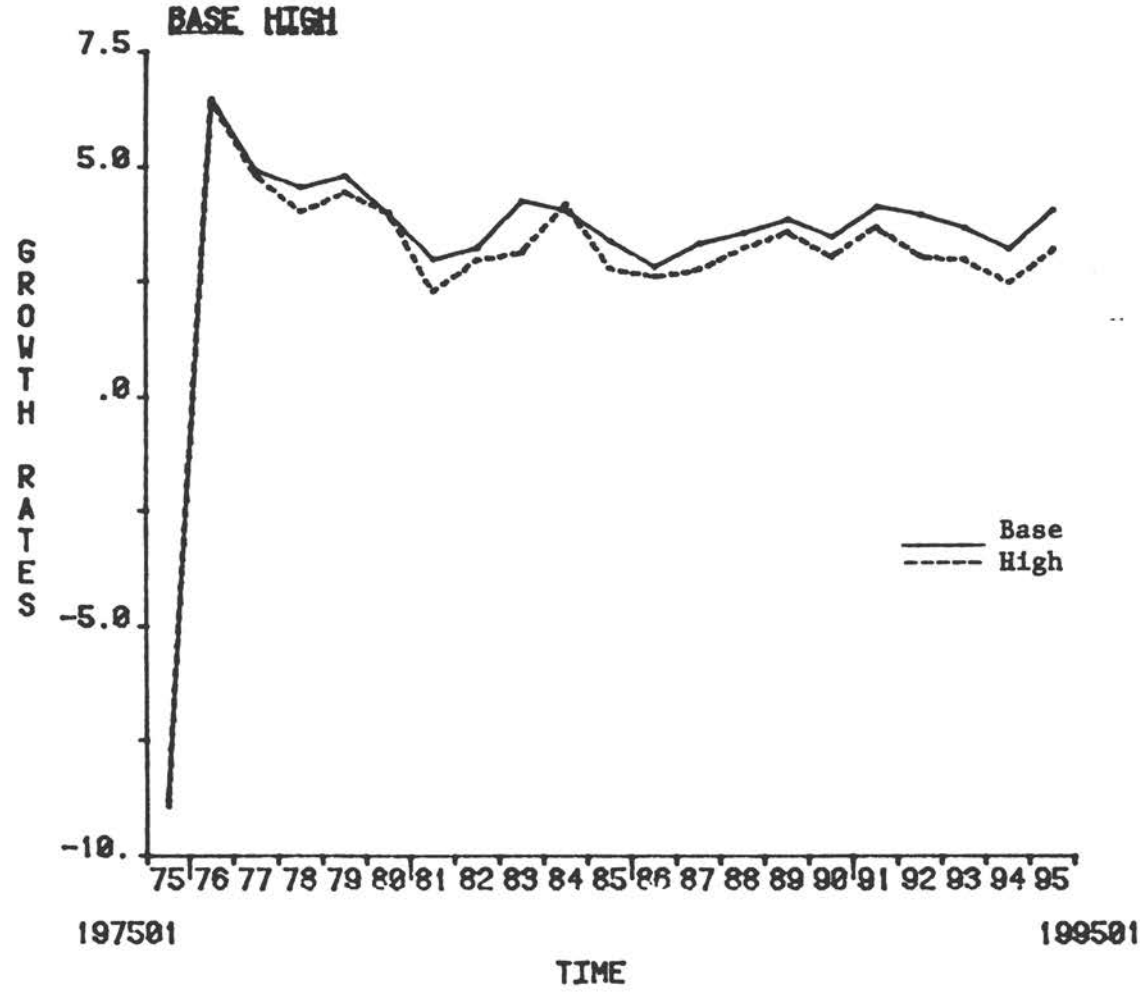


FIGURE 10 Tons shipped control vs. alternate growth rates, 1975-95. SOURCE: R. Epstein, *et al.* The Demand for Transportation. Wharton EFA, Inc., June 1978.

appears to be the current policy, then that would indicate the demand for increased coal shipments should certainly be realized.

The crude petroleum and gas projections, on Table 1, are probably overly optimistic. It is unlikely that we could continue to increase domestic production at quite this rate through 1995. As you will note, on the same table, we have a slower growth of tons shipped in crude petroleum and gas than the rate of growth of output in the projection period.

The growth rate for the metal mining sector is too high in terms of the output originating, and therefore we have reduced it in terms of the tons shipped. In nonmetallic mining, the growth rates of output and tons shipped are actually pretty comparable.

Most of the comparisons historically here are bedeviled, of course, in terms of the period that one uses, in terms of the breaks in the data, and in the admittedly very imperfect estimates that we have made of private carrier activity. We have considered in great depth the apparent weaknesses of the historical data, and I am perfectly prepared to admit this. One of the major research goals, I believe, lies in the field of improving the historical type of information so that the resulting data base could support the research more appropriately.

Hopefully, the new forthcoming census will give us a better benchmark to compare some of these projections.

SPEAKER: During your presentation you portrayed agriculture increasing at a rate of 1/2 percent per year, while food products were at 4 percent per year (Table 1). How would you account for this?

DR. LOXLEY: The processed foods output and shipment primarily reflect changes in technology, as well as the types of foods that are being shipped. These are all types of processed foods, so it is not only fresh food, but also refrigerated, frozen foods, etc. One of the things here that I think we want to explore is precisely this kind of issue that you are raising in terms of what kinds of shifts have taken place in locale of production and locale of consumption. One of the areas where we are moving ahead, in line with the comments of the previous speaker, is in building a multiregional focus on economic activity and population movement. We feel that this is probably one of the better ways to get at transportation shifts.

In terms of the forecast itself that was presented here, the food forecast is the result of the general economic forecast. There is an historical relationship between agriculture and food manufacture. I don't know what, exactly, is causing the different future growth rates, or to what they are attributable. I don't know whether it is a case of shifts in distribution, or whether it is a shift in the type of product that is being produced. I think that each one of these deserves careful, separate investigation.

TRANSPORTATION MODELING AND FREIGHT DEMAND TRENDS

Introduction

John E. Wild
Executive Director
National Transportation Policy Study Commission

It certainly is a pleasure to have the opportunity to meet with you today to discuss the work of the National Transportation Policy Study Commission. Edward Bentz, who is our Director of Impact Analysis, is with me today and he will give you some insight into our approach to projecting future transportation freight system demand.

By way of introduction, allow me to briefly describe the mandate and approach that the commission is taking to its work. The commission is a 19-member panel established by the 1976 Federal Aid Highway Act to recommend policies to the President and to the Congress to bring about a more responsive transportation system through the year 2000. The mandate covers all modes of transportation, both domestic and international, as well as passenger and freight.

Obviously, one of the most important aspects of our work is an attempt to project future demands that our changing society will place upon the transport system.

In an attempt to do so, we have constructed three basic alternative scenarios that we believe will frame the continuum of alternative futures. That is, we have constructed a low-, a moderate-, and a high-growth GNP scenario. It is not an attempt to predict which one of these will occur, but rather an attempt to bound the possible reasonable alternative growth rates.

There are 18 microeconomic variables that drive the scenarios. These variables can roughly be divided into economic and demographic variables. These scenarios, along with several hundred indicators, were used to drive the models designed to help us project the system constraints in land, capital, and energy.

Dr. Bentz will delve more deeply into the specific models used and how we tied them together in a series yielding a consistent output. We will continue to use these models as we develop our policy alternatives for the commission. Our policy development process is to develop three policy alternatives for each issue addressed; that is, we will look at a current policy, a policy that emphasizes a more strict cost-benefit approach, and a policy that emphasizes attainment of a specific goal such as energy conservation.

The next step in our process is to translate the policies from words into data that can be fed into our model. For example, a policy recommendation that the Interstate Commerce Commission (ICC) rate structure should be altered to be cost-based rather than value-based is meaningless unless we can analyze its impact on such issues as modal split, increases or decreases in ton-miles over certain routes, return on investment, and shipper preference.

Out of this process, we hope to derive the impacts of alternative policies to give our commissioners an opportunity to intelligently and knowledgeably choose among alternative policies. In this manner, we hope to avoid policy recommendations that have down-stream impacts of which we are unaware.

TRANSPORTATION MODELING AND FREIGHT DEMAND TRENDS

Edward J. Bentz, Jr.
Director, Impact Analysis
National Transportation Policy Study Commission

I welcome the opportunity to be here today and to share with you some of the work that is now in progress that John Wild has just introduced to you. We hope the methodologies to be described will help provide a structure that we can follow up in the sessions of the workshop. I would like also to identify colleagues in the audience who have been working with us and who are part of our team. Ed Margolin has been particularly helpful on the coal effort, and Ed Blum from the Department of Energy has worked with our energy group. Both have been interacting as part of a cohesive team on the work we are trying to do.

The work I will describe is now in progress, and I would like to focus on the methodology we have been developing to forecast the demand, and especially, in view of the objectives of this workshop, to identify, to the best of our knowledge at present, the factors that affect the demand over time.

As Deputy Secretary Butchman mentioned in his opening address, we have to focus on all the demand to "get a handle" on testing key policy areas. Various commodity movements (coal, grain, etc.) all compete for capital in the marketplace; they are all subject to the same forces, perhaps to different degrees, and especially to concerns such as cost, energy use, or environment.

Historically, transportation has been termed the safe and efficient movement of goods and people, but I would say that probably since 1969, a number of "constraints" or additional requirements--other national goals--have been added. Now, a more apt statement is, "the safe and efficient movement of goods and people with minimum adverse environmental impact, with minimum adverse energy loss, and perhaps with minimum capital requirements in the future."

As Professor Klein and his colleagues have mentioned, a model provides a consistent framework for looking at alternate policies. It is not an answer in itself; it is just a tool. And, of course, different models built for different purposes have different capabilities and different areas of application.

What we have tried to do at the Transportation Commission, in response to our mandate, is to attempt to bridge the gap between the national aggregated models, those fine models that help to relate national transportation activity to national behavior, and, on the other hand, the very geographically disaggregated modal-specific models that we are all

familiar with in the transportation sector. These disaggregated models are designed for very specific purposes, and, indeed, enormous data base efforts and methodological development have gone into them. Our hope is to bridge this gap and to explore in particular one of the key features that the Congress has asked us to examine--one that, as you know, very much shapes transportation--that is, the regional demand and supply picture.

Just as the issuance of an "average size 8 shoe" to people who need "size 5" and "size 10" shoes doesn't help either group, similarly regions are very different, and one must look at the regional differences. (For example, our Congress and Administration has been very active in the last 18 months just trying to decide one regional issue in energy; namely, natural gas, which has very strong regional impacts.) Since transportation is truly a derived demand--derived from other goals--in order to serve those goals, it is very important to try to explore the regional differences, particularly as they relate to capacity and to competition, two keynotes in transportation.

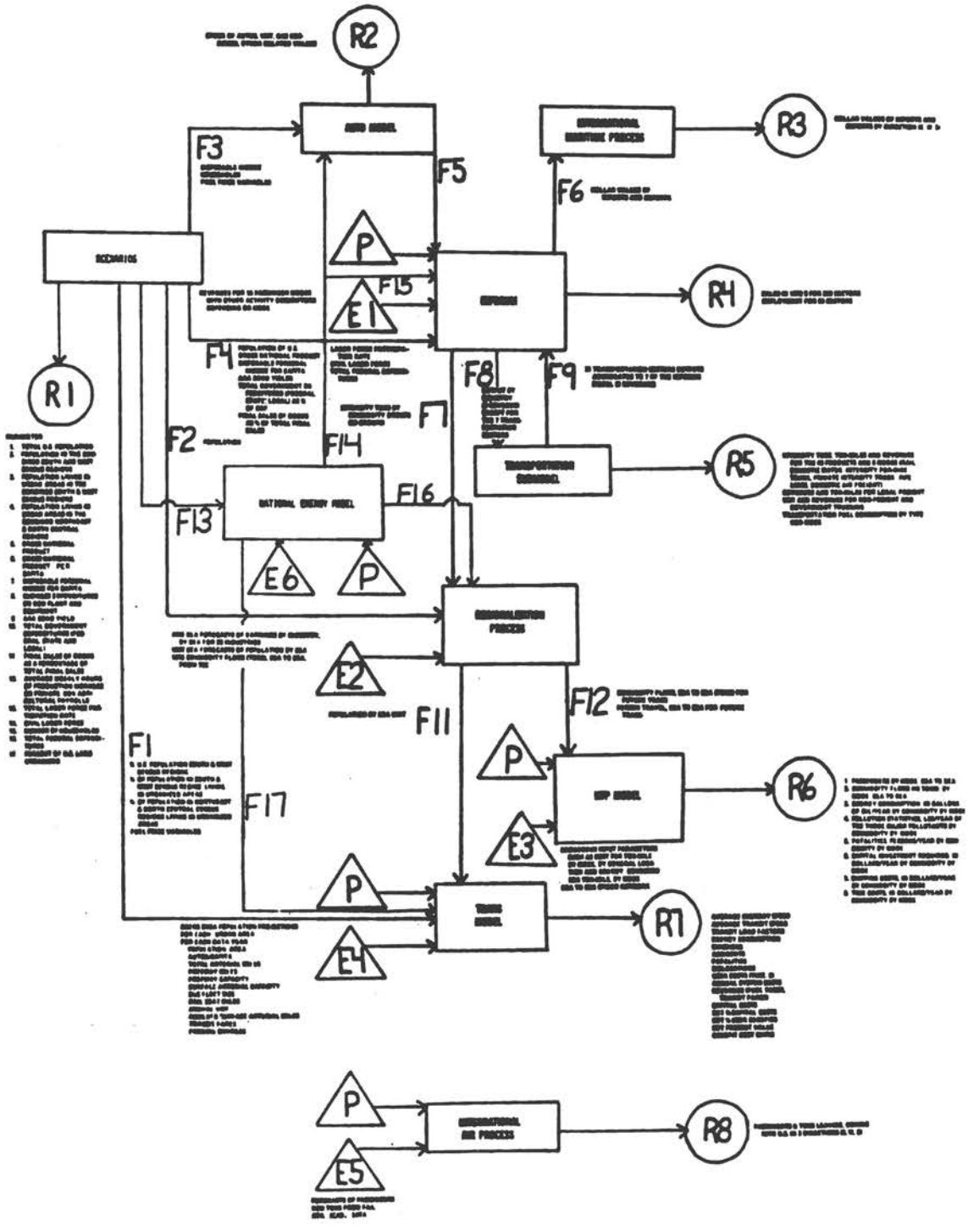
With that in mind, I would like to describe what we have been doing in terms of the modeling methodology and once again to reiterate two facts about which we are very happy: first, that the activity is a joint effort with the Department of Energy, and second, that it builds on much of the early pioneering work of the Department of Transportation. Without the cooperation of the Department of Transportation, the Department of Energy, and indeed other agencies, particularly the Environmental Protection Agency, the National Science Foundation, and the Federal Reserve Board, we would not even have been able to attempt to start it.

Using Figure 1 (Schematic of Model) as a reference I will go quickly through the outline of the model chain. There are actually 10 major models, and I plan to comment briefly on only a few of the key elements, because my time is limited. Then perhaps at the later workshop sessions we can explore them more fully.

The first box includes what we call the scenarios, and they are three alternate pictures of what the possible future may be. Why do we use scenarios? Well, we all know that most very fine economic structural models are built to reflect historical economic behavior, and sometimes what happens in our economy is that economic structures change. That may occur either because of technological innovation, or because of changes in attitudinal life-styles that we can't easily forecast. So what we wanted to do is to develop three different baselines that attempt to span the envelope of three possible alternate futures in a very crude, coarse way.

And these scenarios, as John Wild mentioned are driven by some 17 macroeconomic variables. (These are depicted by R1 in Figure 1.) In fact, our middle baseline looks similar to one of the Wharton forecasts. Also, part of our effort in establishing these scenarios is to compare them where appropriate, with each of the major macroforecasts that are in current use in the private, the public, and the international sector.

In the next step, to go quickly through the chain, the scenarios "push" first a national set of models, both national economic and national transportation (modal) models, and these in turn "push" regional transportation models.



WTPSC FORECASTING METHODOLOGY

F1 through F12 are intermodel flows of information.

E1 through E 5 are external data sources of particular interest.

R1 through R 8 are outputs of the models.

P is a Commission proposed policy.

FIGURE 1 Schematic of model. SOURCE: National Transportation Policy Study Commission, 1978.

To reiterate, scenarios push Inforum. Inforum is a national economic model developed at the University of Maryland. It is a macroeconomic structural model, similar in parts to the Wharton model, and somewhat similar to the Chase model or the Data Resources, Inc., model. It is basically an input-output (I/O) model. There are numerous sectors in its replication of the economy. That model (Inforum) in turn "drives" a national auto model that happens to be the Jack Fawcett auto stock model--basically an auto stock pricing model. It is national--it gives a look at national auto behavior. It has a weakness--it does not have in its stock inventory some of the newer fleet inventory components such as light-duty trucks or vans. As everyone here knows, trucks and vans have been soaking up a larger percentage of the new sales markets. Hence, we do not look at them using this specific model.

Also, on a national basis, is the Fawcett transportation submodel. It is a national freight model; it basically looks at about 40 commodity classes of freight movement. I think in the material given to participants there are typical forecasts of what this freight model predicts.

These national models in turn give something of a "quick look" at the national behavior. They, in turn, "drive" through a "regional process" (see Figure 1)--which took a great deal of developmental effort--to break down (regionalize) and "feed" several regional models. Let me identify what these are. First is the National Transportation Planning model (NTP) (see Figure 1), originally developed by the Department of Transportation. This was very much designed to look at intercity freight, basically 19 commodity classes, and was disaggregated by 173 Bureau of Economic Analysis geographical zones. Second, in parallel, on Figure 1, is the TRANS model, which is really two models. There is an urban model--basically an urban model predominantly for passengers. This model is calibrated and run for each of the approximately 250 metropolitan areas with the data base on each of those areas. There is also a parallel model called the TRANS "rural" model, and it attempts to accomplish a similar function in the rural market, and this rural market is mainly an auto and light-duty truck model. We also model urban "goods" movement.

Similarly, although not shown on Figure 1, there are links that "hook" up to the international aviation process on Figure 1, basically passengers and freight, and that are based on three international markets. At the top of Figure 1 the international maritime process is shown. It basically looks at, for each of the nine coastal districts, the 84 different commodity classes shipped in and out of the country and includes both port requirements and ship requirements. I will now only briefly mention the National Energy Model (NEM)--that is both a national and international model and I will say more about that later. I should add, all these models are linked and coupled, sharing a common, consistent, and compatible set of inputs, and assumptions.

Let me now briefly comment on the elements that are contained in some of the features of the models. The elements are, first, with regard to scenarios, at least what the GNP looks like; second, what new technological information has been put into these models to reflect technological change in the transportation sector (and in the energy

sector that fuels the transportation sector); and third, the regional coal movement, and the factors that affect coal movement. I will talk a bit about this last item as an example.

Looking at Figure 2, we see one very brief snapshot of three different baselines in terms of GNP. As you can see, in the year 2000, these GNP forecasts differ from a slower growth to a higher growth. There are 17 other parameters coupled to these, including productivity and many other factors. Perhaps, at the workshop, we can look at the other parameters.

In Figure 3 we have tried to exogenously and implicitly identify the current technologies from the present until the year 2000 that would affect transportation activity, and to explicitly couple them into the model. To do that, one first needs to know what they look like. We accomplished this by a separate effort by initially looking at 400 candidate transportation technologies. In the process, we used surveys, in-house work, and literature searches. We then boiled those 400 down to 27 "priority" technologies. We must thank many of the government agencies and some 80 different manufacturing and carrier companies, as well as citizen groups, who provided information that allowed us to do the job. For example, General Motors on the highway section provided a 6,000-page response on what they believed were the different priority technologies and what they thought were the criteria needed to judge them.

Looking at Figure 3 again, there are 7 technologies in the highway area that we found. In each of the 27 technologies identified, covering all modes, we examined the cost, safety, environmental, and energy characteristics. Then we looked separately into the determination of the market penetrations for each of these technologies. We looked at what demands they would place on the supply sector, particularly fuel, and indeed upon other commodities such as scarce raw materials. For example, the reduction catalysts on new cars may pose an important supply constraint for scarce raw materials.

Looking at Figure 4, in the marine sector, you will notice that not all the technologies are conventional physical hardware, but they run the gamut of what we call the soft technologies; that is, basically institutional changes that reduce operating costs and reduce the high variable costs we are familiar with.

I will just mention one type of institutional change, an air transportation example. Delta Airlines last year saved $35 million in fuel cost by basically instituting improvements in their operational procedures. This was a very real saving. And it is one of those institutional changes characterized by the fact that it took very little increase in capital and capability to implement it quickly.

On Figure 5 are the air transportation and pipeline areas. If I may, let me mention slurry pipelines later, in the discussion on coal. That is a separate major area of our study. I will now go on to energy considerations.

To begin, look at Figure 6, that is the model diagram again, in a simplified form. There is the block called National Energy Model. Basically, it is the model SRI International has developed over the past years. It is a national energy model, a supply-demand price model, and is very strong in the energy supply sector. I would say that its weak-

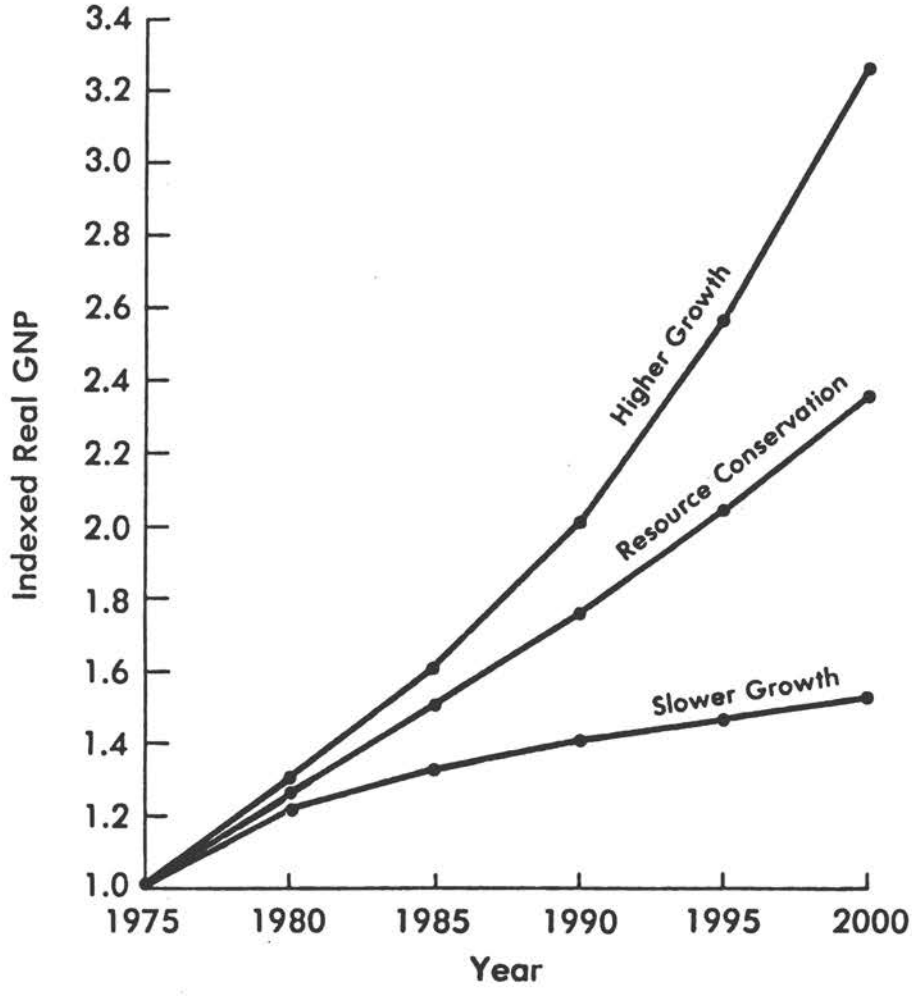


FIGURE 2 Projected real GNP indexed to the year 1975. SOURCE: National Transportation Policy Study Commission, 1978.

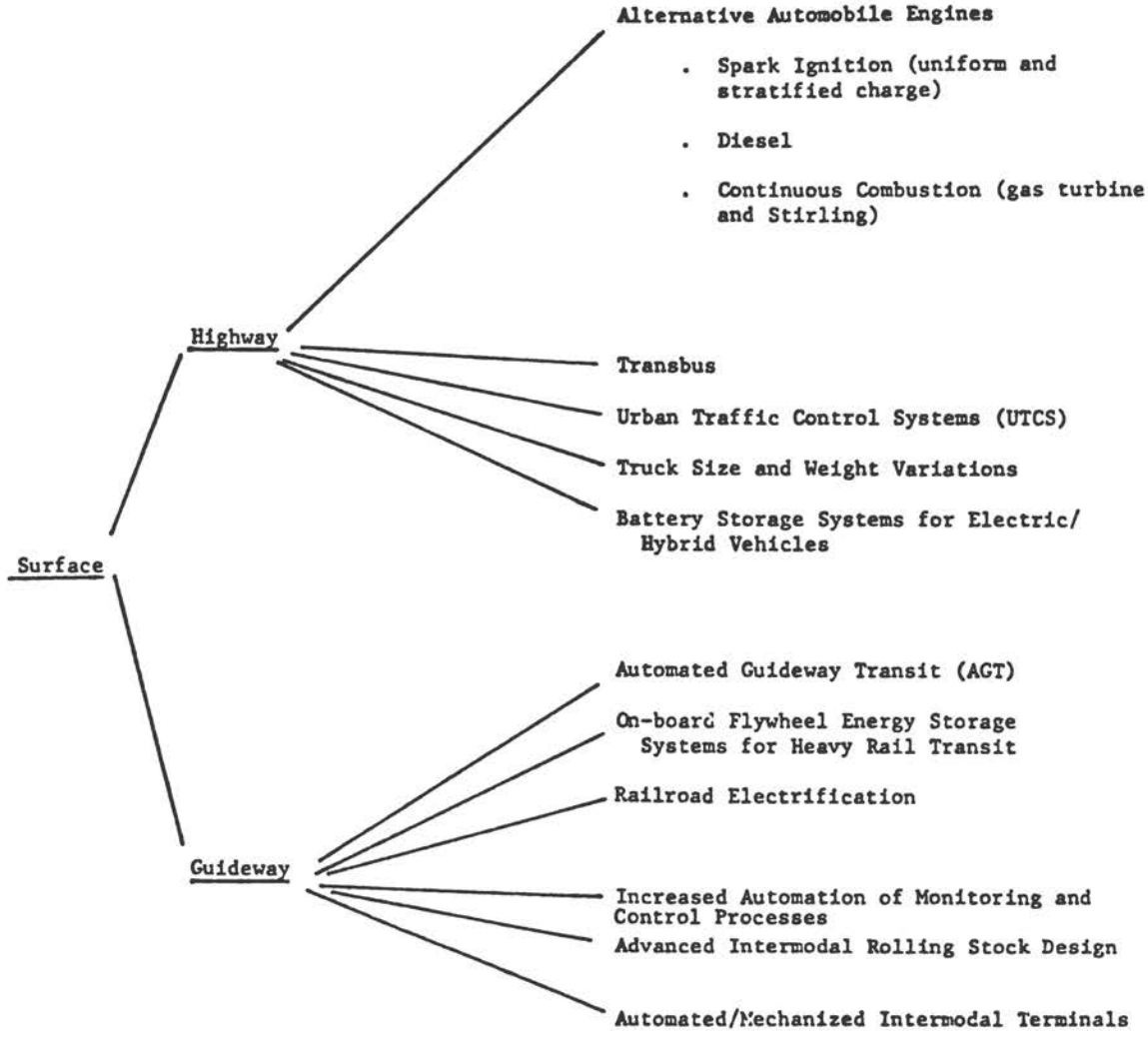


FIGURE 3 Priority technologies. SOURCE: National Transportation Policy Study Commission, 1978.

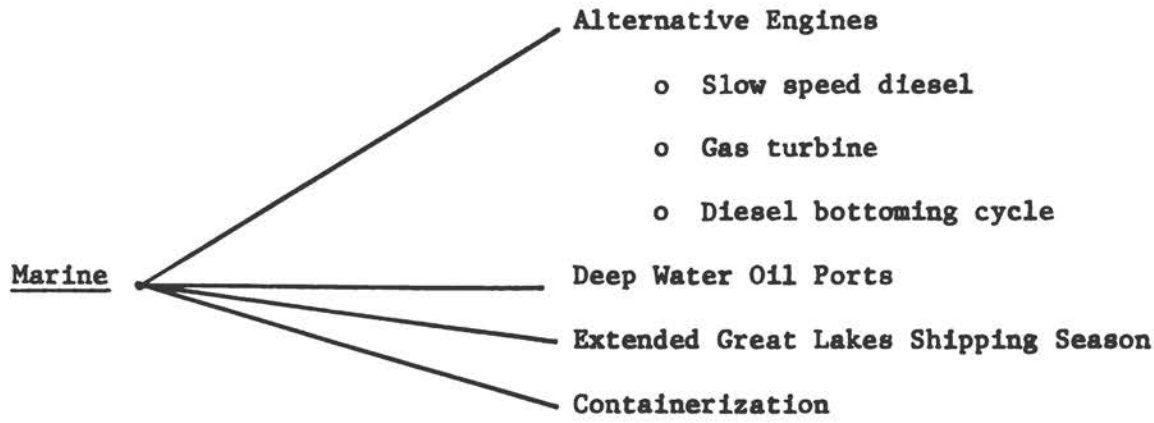


FIGURE 4 Priority technologies. SOURCE: National Transportation Policy Study Commission, 1978.

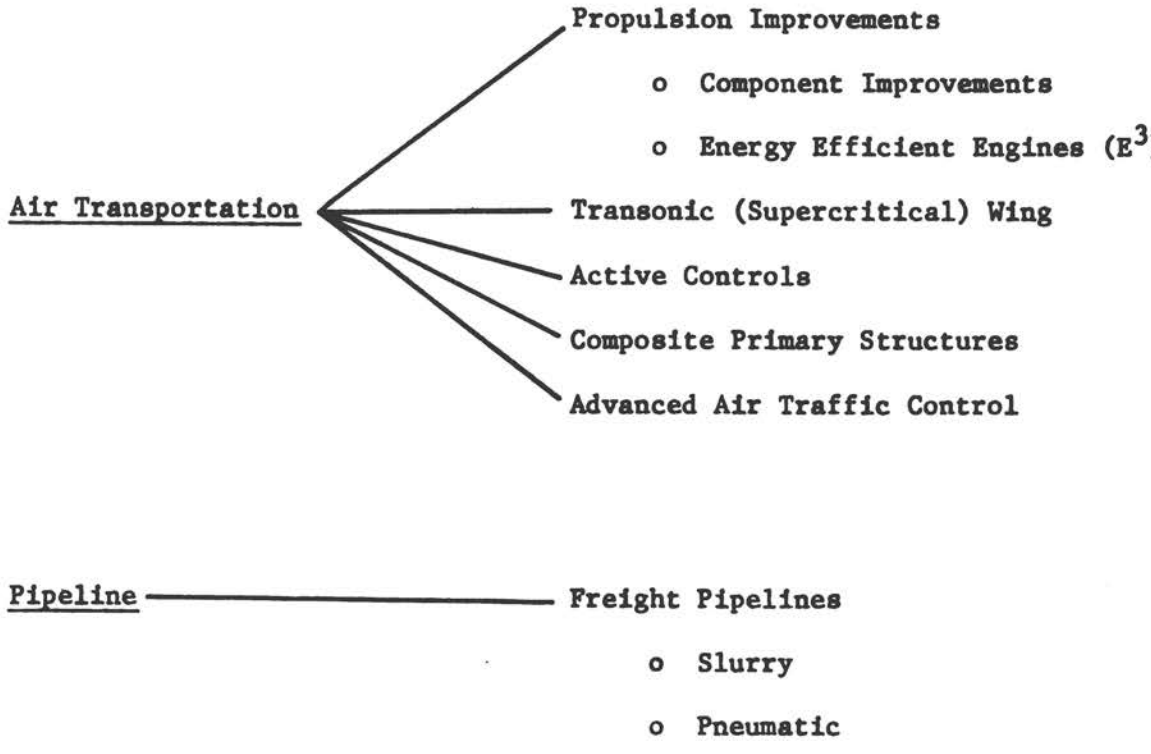


FIGURE 5 Priority technologies. SOURCE: National Transportation Policy Study Commission, 1978.

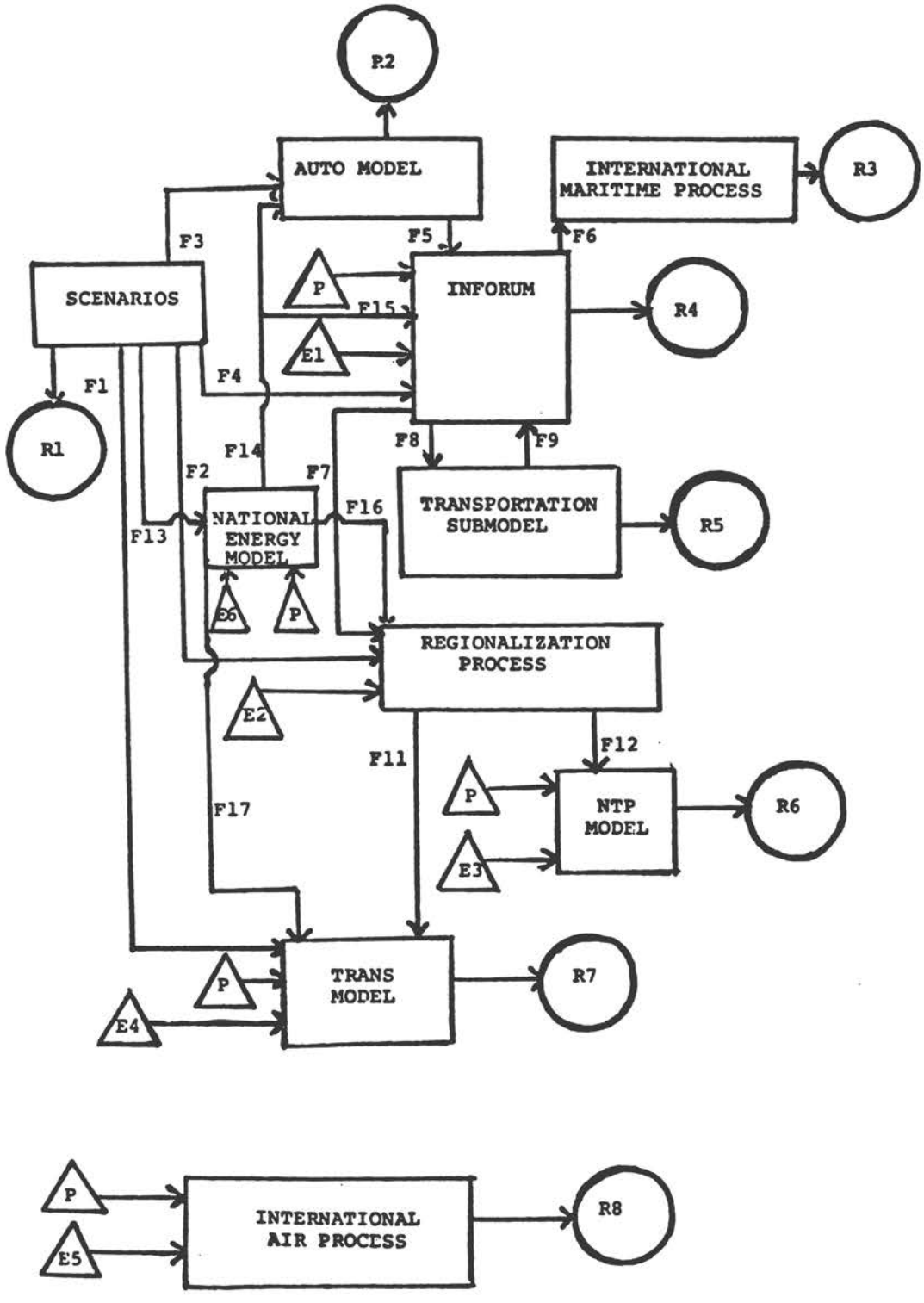


FIGURE 6 Simplified model diagram. SOURCE: National Transportation Policy Study Commission, 1978.

E1: -- Revenues for 18 passenger modes with other activity descriptors depending on mode

E2: -- 1972 BEA forecasts of earnings by industry, by BEA, for 20 industries
-- 1972 BEA forecasts of population by BEA
-- 1975 commodity flows (tons), BEA to BEA, from TSC

E3: -- Exogenous input parameters such as cost per ton-mile by mode, by general location and energy consumed per ton-mile, by mode
-- BEA to BEA spider networks by mode

E4: -- OBERS SMSA population projections
For each urban area -
For each data year -
population
area
autos/capita
total arterial miles
freeway miles
freeway capacity
surface arterial capacity
bus fleet size
rail seat miles
annual VMT
annexed surface arterial miles
transit fares
parking charges

E5: -- Forecasts of passengers and tons from FAA, ATA, ICAO, IATA

E6: -- U.S. population
-- GNP/population
-- Rural households/total households
-- Industrial value added/GNP
-- Value added primary metals/industry value added
-- Value added/food/industry value added
-- Value added paper/industry value added
-- Space heat/urban population
-- Rural heat/rural population
-- Miscellaneous heat/urban population
-- Air-conditioning/population
-- Residential electromechanical/GNP
-- Space/heat/commercial value added
-- Electromechanical/commercial
-- Miscellaneous heat/commercial value added
-- Air-conditioning/commercial value added
-- Coal exports
-- Urban passenger miles traveled/urban population
-- Rural passenger miles/GNP

FIGURE 6 - Continued

-- Share urban passenger miles traveled by bus
-- Share rural passenger miles traveled by air
-- Truck fuel/GNP
-- Rail fuel/GNP
-- Marine fuel/GNP
-- Air freight/GNP
-- Lubes/vehicle miles traveled
-- Aircraft fuel/passenger miles traveled
-- Bus fuel/passenger miles traveled
-- Coal share of feedstock
-- LPG share of feedstock
-- Gas share of feedstock
-- Naphtha share of feedstock
-- Population (persons)
Region 1
Region 2
Region 3
Region 4
Region 5
Region 6
Region 7
Region 8
Region 15

F1: -- % U.S. population South and West Census Regions
-- % of population in South and West Census Regions living in urbanized areas
-- % of population in Northeast and North Central Census Regions living in urbanized areas
-- Fuel price variables

F2: -- Population

F3: -- Disposable income
-- Households
-- Fuel price variables

F4: -- Population of United States
-- Gross National Product
-- Disposable personal income per capita
-- AAA bond yields
-- Total government expenditures (federal, state, and local) as % of GNP
-- Final sales of goods as % of total final sales
-- Labor force participation rate
-- Civil labor force
-- Total federal expenditures

F5: -- Index for auto VMT (all auto travel)

F6: -- Dollar values of imports and exports

FIGURE 6 - Continued

F7: -- Intercity tons by commodity group (20 groups)

F8: -- Output by industry ($ revenues) except for the seven transportation sectors

F9: -- 31 transportation sectors outputs aggregated to seven of the INFORUM Model ($ revenues)

F11: -- Population by BEA unit

F12: -- Commodity flows, BEA to BEA (tons) for future years
-- Person travel, BEA to BEA for future years

F13: -- GNP and population

F14: -- Fuel price

F15: -- Energy consumption, fuel prices

F16: -- Matrix of energy commodity flows between production and consumption regions, fuel prices

F17: -- Fuel prices, fraction of electricity produced by different energy sources

R1:
1. Total U.S. population (including armed forces abroad)
   a. total numbers
   b. same age distribution as Census Bureau
2. Resident population in the combined South and West Census Regions as a percentage of total resident population of the United States
3. Population living in urban areas (using the 1970 definition of urban areas) as a percentage of the total resident population in the combined South and West Census Regions
4. Population living in urban areas (using the 1970 definition of urban areas) as a percentage of the total resident population in the combined Northeast and North Central Regions
5. Gross National Product
   a. growth rates
   b. constant 1975 dollars
6. Gross National Product per capita (constant 1975 dollars)
7. Disposable personal income per capita (constant 1975 dollars)
8. Business expenditures on new plant and equipment
9. AAA bond yields
10. Total government expenditures (federal, state, and local)
11. Final sales of goods as a percentage of total final sales
12. Average weekly hours of production workers on private nonagricultural payrolls
13. Total labor force participation rate (number of persons 16 years of age and employed or actively seeking work as a percentage of total noninstitutional population 16 years of age and over)
14. Civil labor force

FIGURE 6 - Continued

15. Number of households
16. Total federal expenditures
17. Percent of U.S. land urbanized

R2: -- Stock of autos
-- VMT
-- Gas consumed
-- Other related values

R3: -- Dollar values of imports and exports by direction (E, W, S)

R4: -- Sales in 1972 $ for 200 sectors
-- Employment for 96 sectors

R5: -- Intercity tons, ton-miles and revenues for 48 products and six modes (rail, domestic water, intercity for-hire truck, private intercity truck, pipelines, domestic air freight)
-- Revenues and ton-miles for local freight
-- VMT and revenues for nonfreight and government trucking
-- Transportation fuel consumption by type of fuel and mode

R6: 1. Passengers by mode, BEA to BEA
2. Commodity flows (in tons), by mode, BEA to BEA
3. Energy consumption, in gallons of oil/year by commodity by mode
4. Pollution statistics, lbs/year of the three major pollutants by commodity by mode
5. Fatalities, persons/year by commodity by mode
6. Capital investment required, in dollars/year by commodity by mode
7. Shipping costs, in dollars/year by commodity by mode
8. time costs, in dollars/year by commodity by mode

R7: -- Average highway speed
-- Average transit speed
-- Transit load factors
-- Energy consumption
-- Emissions
-- Accidents
-- Fatalities
-- Dislocations
-- User costs (time, $)
-- Annual system costs
-- Revenues (fuel taxes, transit fares)
-- Capital costs
-- Net % capital costs
-- Net % user benefits
-- Net present value
-- Benefit cost ratio

R8: -- Passengers and tons leaving, coming into the United States in three directions (S, W, E)

FIGURE 6 - Continued

ness is its demand sector that is very small, and very aggregated. But since we have been developing through all these other demand models a detailed model of disaggregated demand for transportation, we are mainly interested in their energy supply sector.

SRI International has also recently developed a world energy model that "feeds" into the national model. This focuses on changes in the world market such as foreign capacity. This is particularly important if, for example, Saudi Arabia decides to limit production capacity in the future (maybe to 8.9 million barrels a day), or if there is a future oil cartelization (as there is now), and this is reflected in increased oil price changes. The world energy model then inputs into the national energy model. Basically what we have done here is to try to take apart this national model, and replace its demand sector in the transportation sector by all of our transportation markets demand models.

One example of the changes that we incorporated are those of modal efficiency (which we are all very interested in for many reasons). They affect costs, mode split, and certainly the goal of achieving conservation. This change was a pretty "tall" effort in itself, because, as you know, each of these models is designed in a particular way, and the way they "fold in" demand is different. So we had to uncouple all the demand sections and to "lump them in" with the national energy model. This required numerous linkages and consistency checks. We are finally in the process of running this out.

I will show you some of the elements of that process and discuss why we wanted to use this special energy model coupled to our transportation model. It is that we didn't feel comfortable with the energy information contained in the Inforum model. We feel that supply constraints through the pricing mechanism are very important for the future, and we wanted a model with interfuel competition, because in the real world, on a regional and national basis, coal does compete with oil and does compete with natural gas at a certain end-user price. One won't have a feel for future prognosis unless there is intersectoral, interfuel competition built in for both the conventional fuels, oil and natural gas, and for uranium for the generation of power, as well as for the oncoming conventionals, and we might include the Atlantic offshore production, as well as the synthetics from coal and from the alcohols (alcohols used for blends in gasoline at present in the Midwest).

There was another reason; that reason was very simple. In order to achieve the energy goals stated by the President, to move 1.2 billion tons of coal a year by 1985, there is going to have to be a system to move it. As Deputy Secretary Butchman said, one of the first efforts of the Department of Transportation was to look specifically to 1985, to determine the ability of the transportation system to move that 1.2 billion tons of coal.

However, as many are aware, the problems generally begin after 1985, and that is also the time when, as many of the forecasts external to our effort say, there may be a "short-fall", or at least there may be a higher price for fuel. (The forecasts referred to are the CIA, Carol Wilson's effort at MIT, the recent International Energy Agency forecast, and the American Petroleum forecast.) So in any case, we need

to look specifically at the ability of the system to move these conventional and synthetic fuels on a regional basis, and "regional" is the key word here.

We believe it is the regional bottleneck problem that we will have to face. We know already that in 1974, when we had those large shipments of grain to the Soviet Union, that our locks and dams and inland waterway system was very quickly put to the test. What is going to happen if we are to move three times the 1976 tonnage of coal on the same system that had congestion problems even in 1974? When you consider that on the average it takes 20 years for construction (from authorization for start of construction to actual operation) of locks and dams, it is clear we need to get started now for things required by 2000. I am afraid we don't have much time.

Basically, this "snapshot" was an attempt to show some of the processes, some of the energy technologies that are residual or inside our energy model. With that in mind, I would like to say briefly what we derived from the forecast and take a quick look at the key factors that we think, so far, affect the coal market.

We are very very concerned in all these forecasts with the environmental impacts of these forecasts, because they are very real. Some people would say they even are a constraint to future transportation activity. So for each of these markets, we have a separate effort that looks at the environmental impacts and at what the environmental prognosis is for 2000.

Similarly, one of our major efforts, as John Wild mentioned, is that we are specifically looking in all these transportation markets, and for coal in particular, at the capital, labor, and land requirements associated with these movements. And by capital I mean not only how many locomotives are required, for example, but also what the ability is in a particular sector to generate that capital in light of the regulatory and market environment that currently exists.

With that in mind, I would like to focus on coal, because I think that highlights some of these points. One of the reasons we looked at coal, of course, is that basically we felt that the President's goal to reduce the nation's dependence upon imported fuels--oil and natural gas--and to develop our own national resources was a very noble goal, but a goal that required answers to many questions before it could be achieved.

The first thing we tried to do was to determine the factors that we felt affected the markets for coal, in fact, for different types of coal. And that meant factors in the supply sector and factors in the demand sector (or usage sector). That would determine whether the coal would be moved at all, and, if it would be moved, where, and at what price. On the supply sector, we identified the regulatory requirements such as federal leasing requirements, strip mine regulation requirements, as well as labor productivity. On the demand side, the environmental siting requirements for industrial coal-fired boilers are very real in view of the 1977 Amendments to the Clean Air Act--especially in terms of an approaching promulgation of the new Source Performance Standard Regulations that may have a very real effect on how much western coal is moved rather than eastern coal.

In the transportation sector, the factors that we identified are, in particular, the price and tariff structure of the modes concerned; the capacity (based on what we feel are the projected flows, i.e., where they are going to be, whether the system will have the capacity, and where the bottlenecks are); whether the system has the ability to overcome these bottlenecks; the very real adequacy of service questions; and the very real introduction of new technologies like coal slurry. Doing that, we first pinned down the regional supply and demand, and price forecasts for coal, as well as for other competing fuels. We are now developing forecasts for these regional coal movements by all modes--in particular looking at the questions of cost, subsidy, capacity, and modal competition.

In conclusion, I should note that we are now in the middle of a special effort in the coal study to identify the total regulatory environment, the environment for rate-setting or price, leasing regulations, taxation and severance requirements, and, through that, trying to assess what the gaps and conflicts are in the regulatory environment and how they affect the ability of the modes to move the coal--if indeed the coal can be moved at all.

DISCUSSION

DR MOSES: Could you please explain in a bit more detail the process by which you go from national aggregates to regional aggregates. Since transportation is essentially a geographic phenomenon, unless the information on movements is converted into meaningful geographic estimates, there is really very little one can say about transportation. Even the modest, the medium forecasts that you have run about 1.2 billion tons of coal to as much as 2.8 billion tons. That means there is a very significant increase in the amount of capacity of the system over the years that you projected, and one must ask the questions, where is that new capacity going to be located and how does it interact with transportation simultaneously for the determination of the location of facilities?

DR. BENTZ: Those are questions on which we indeed spent a lot of time and have been central questions in our planning. I will try to answer them in the short form, because I think it would take me a day to answer them for all the commodities.

Let me take the energy commodities as an example, and take synthetic fuel development as an example of a real potential new source bottleneck. Consider the liquefaction facilities sited or planned in the West. Part of our effort in the energy model was explicitly to identify and locate regionally the new synthetic fuel plants. Further, we attempted to identify for the new projected synthetic fuel plants the existing transportation infrastructure. By infrastructure, I don't mean only the pipelines to take the potential liquids away, but I also mean the very real infrastructure, such as roads, associated with construction.

In the West, for the new coal areas, like Gillette, Wyoming, the Alliance area, and others, there has been a fantastic growth in the community. There was need for the infrastructure, and indeed the Federal Highway Administration has been very active, both in trying to estimate the structure and to provide for it.

In our approach, we have first forecasted the BEA coal and other commodity flows. We then went to the existing infrastructure maps to locate the railroads, the pipelines, and the waterways. There is also a problem with respect to moving coal in that there may not even be enough water to use methods such as coal slurry pipelines. That fact may eliminate or condition the slurry as a strong possibility in the West.

We projected where there were rail lines next to sources, what the capacity of those lines would be over time, and then estimated the shortfall. We then determined the amount of structure that would have to be built to satisfy that projected flow by mode. Then the question was; do those modes, based on their historical performance or rate of return, and in the new economic climate as evidenced by our inflation rate and our GNP rate, have the ability to raise the capital? Will there be an economic bottleneck? To give another example, in addition to physical capacity constraints for that particular route, is there any socioeconomic constraint that would affect the ability to move the coal that would require more capital (such as the possibility of community disruption)?

As an example, and I don't mean this as a forecast, if an amount of money has to be allocated to build bypasses for some of the small towns on the Burlington Northern line for coal movement, that may certainly affect the equation for capital needs. That is true whether it is through the existing rate structure, through an end user tax, or through a subsidy by the government. That change, if carried out, is going to cost some money.

In looking at each of these things, we recognized that our model had certain weaknesses. One of the weaknesses is that as one goes to regional detail there is a loss of accuracy. So, in parallel to our effort, in the case of coal, we also are working with 18 states who, together, have been doing site-specific studies. These could be described as "bottom-up" studies of requirements where they have regional forecasts that are in many cases corridor-specific forecasts.

We also know that the FRA, through Sections "901" and "504" of the Railroad Revitalization and Regulatory Reform Act of 1976, is looking to 1985 and, particularly, at the capacity and capital requiremtnts. These are very useful for comparison. It is a very strenuous, but needed, process.

Perhaps that doesn't fully answer your question for the description of the regionalization process (see box with that label on Figure 6), but I hope that we can expand on the answer in the workshop sessions.

CORPORATE PLANNING--
MODAL TRANSPORTATION IN WESTINGHOUSE:
CHANGING PATTERNS FOR CHANGING TIMES,
DURABLE MANUFACTURED GOODS

S. W. Herwald
Vice President, Corporate Services
Westinghouse Electric Corporation

Any discussion of Westinghouse and modes of transportation must certainly begin with railraods. That is because the founder of the company, George Westinghouse, was as instrumental to rail transportation as he was to the development of the electrical industry. He was personally responsible for the invention of the air brake, the automatic coupler, and switching and signaling systems--all of which were fundamental to the development of rail transportation. Two companies he founded--Westinghouse Air Brake and Union Switch and Signal--have been key suppliers to the railroads, not only in this country, but throughout the world.

The beginning of what is now the Westinghouse Electric Corporation was in 1886 in downtown Pittsburgh, where 200 men worked in a small shop (Figure 1). The enterprise grew dramatically when Mr. Westinghouse won the "battle of the currents," with Thomas Edison, and proved to the world that alternating current was a safe, reliable means of providing power. In 1894, Westinghouse consolidated several operations and began the manufacture of equipment for the electric utility industry in East Pittsburgh.

As you well know, at that time, the population of the United States was heavily concentrated in the Northeast. But, at the turn of the century, the population center was moving in a southwesterly direction toward St. Louis (Figure 2). To reach this market, Westinghouse used the railroads, which were running with the help of much equipment that carried the Westinghouse name. It was said that George Westinghouse was the only man who could stop the Broadway Limited and other trains on their way from New York through Pittsburgh. All Mr. Westinghouse had to do was stand by the tracks at the East Pittsburgh station and wave his umbrella, and he had convenient transportation to his office downtown.

By the late 1800's our nation's railroad system was largely in place, and shipping by railroad was the common form of transportation. A few manufacturers had the advantage of being located on navigable waterways, but railroads handled the great bulk of shipments from manufacturer to customer. Side tracks for manufacturing plants were as common as the parking lot is today.

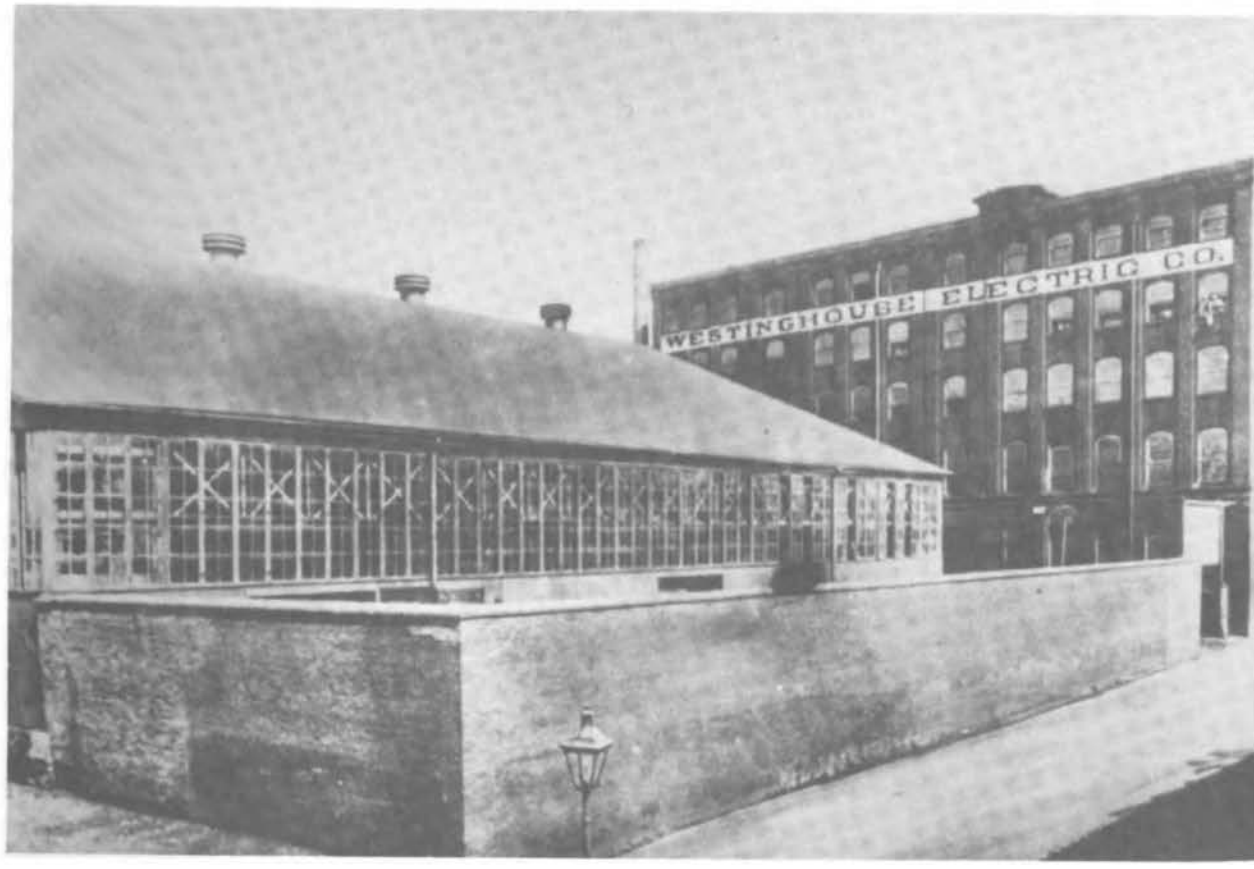


FIGURE 1 Westinghouse Electric Corporation, Pittsburgh, Pennsylvania, 1886.

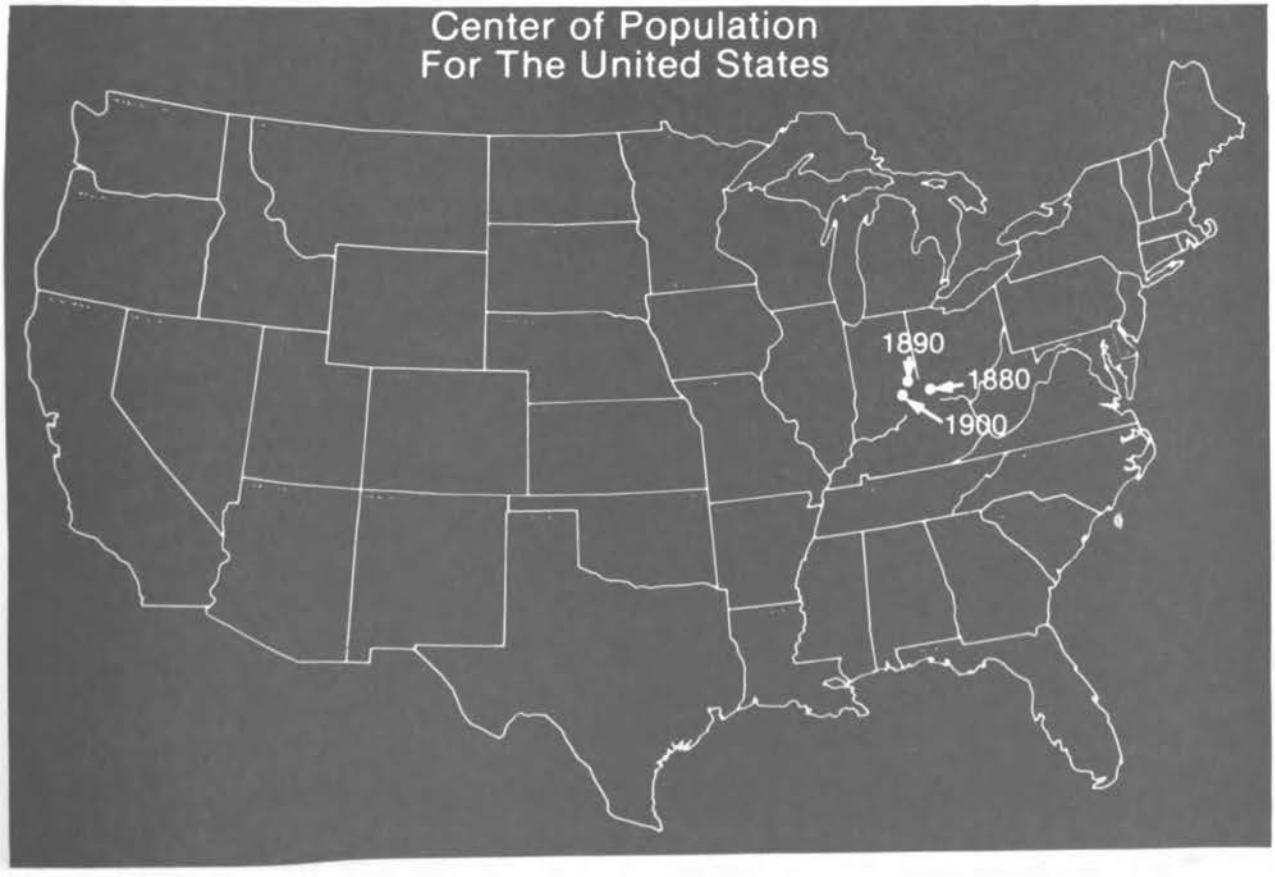


FIGURE 2

During the years 1890-1940 vast changes were to occur. The Westinghouse Company grew and expanded into many diverse businesses. Sixteen additional manufacturing locations were established for various products invented or patented by George Westinghouse (Figure 3). This naturally expanded the market for Westinghouse products and enlarged the young company's transportation needs.

During this period, the stage was set for motor transportation to emerge as a viable alternative to rail shipping. First, the technological development of the motor vehicle progressed to the point where larger and more efficient trucks were avialable, and the pneumatic tire gave them an ease of handling. Second, the nation's highway network was significantly expanded. The combination of these conditions allowed heavier shipments to move over the roads, and for longer distances, and gave rise to the trucking industry. By the year 1935, because of the prolific growth of motor carriers, severe competition developed in the trucking industry. The government, through the Interstate Commerce Commission (ICC), began to regulate the motor carriers. By the late 1930's highway carriers had advanced to the point of becoming effective competitors of the railroads in many areas of the country.

The World War II years placed unprecedented demands on the nation's transportation system. Although the railroads continued to play a dominant role, the tremendous quantities of material to be transported gave impetus to the development of the motor carrier industry. As a result, by the end of the war, the trucking companies were ready for a major expansion.

And it was the same story in industry. Because of the shortages created by the war, industries all over the nation were caught up in major expansions. In the immediate postwar years of the 1940's, Westinghouse built or acquired 10 additional manufacturing plants. All but 2 of these--Little Rock, Arkansas, and Sunnyvale, California--were in the Northeast (Figure 4).

By now competition between the railroads and the motor carriers had grown tremendously. In 1950, motor carriers were handling twice as much Westinghouse shipping as they had 10 years before. In the late 1940's, the length of trailers went to 32 feet, and with improved types of tires and brakes and more powerful engines, the motor carriers were able to handle larger and heavier Westinghouse products.

Also, the flexibility of trucks to make deliveries at construction sites meant substantial economies to many Westinghouse divisions. For example, the Elevator Division could ship elevators and electric stairways directly to large building sites in downtown metropolitan areas. Motor carriage eliminated the need for expensive blocking and bracing that was required for rail shipments. Likewise, the total delivered cost was reduced because there was no need for transloading and truck delivery costs from rail heads to the job site.

The transit-time advantage of motor carriers over the railroads did more than bring better customer service. It also opened up the opportunity for manufacturers to reduce and control inventory levels--an item of expense that was getting more and more attention in management science.

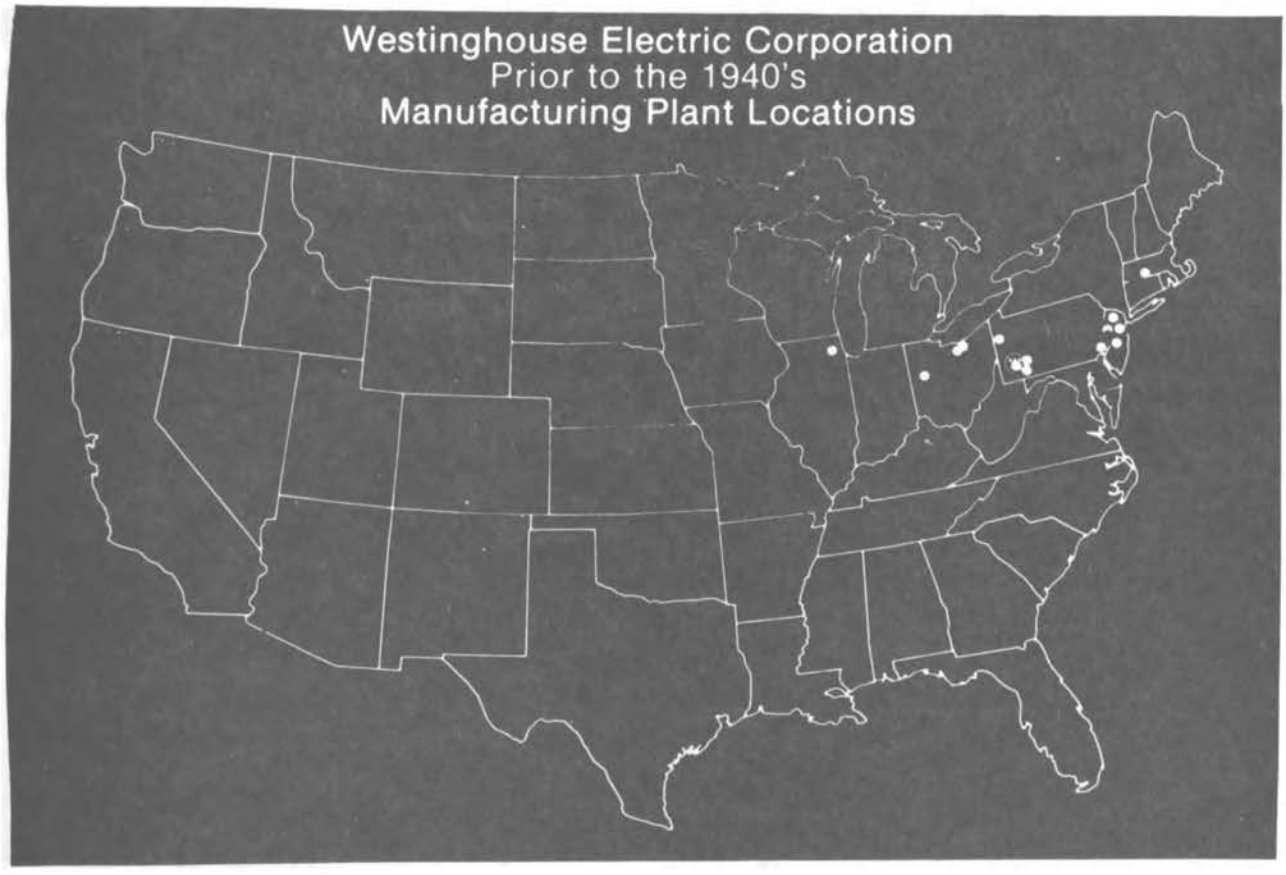


FIGURE 3

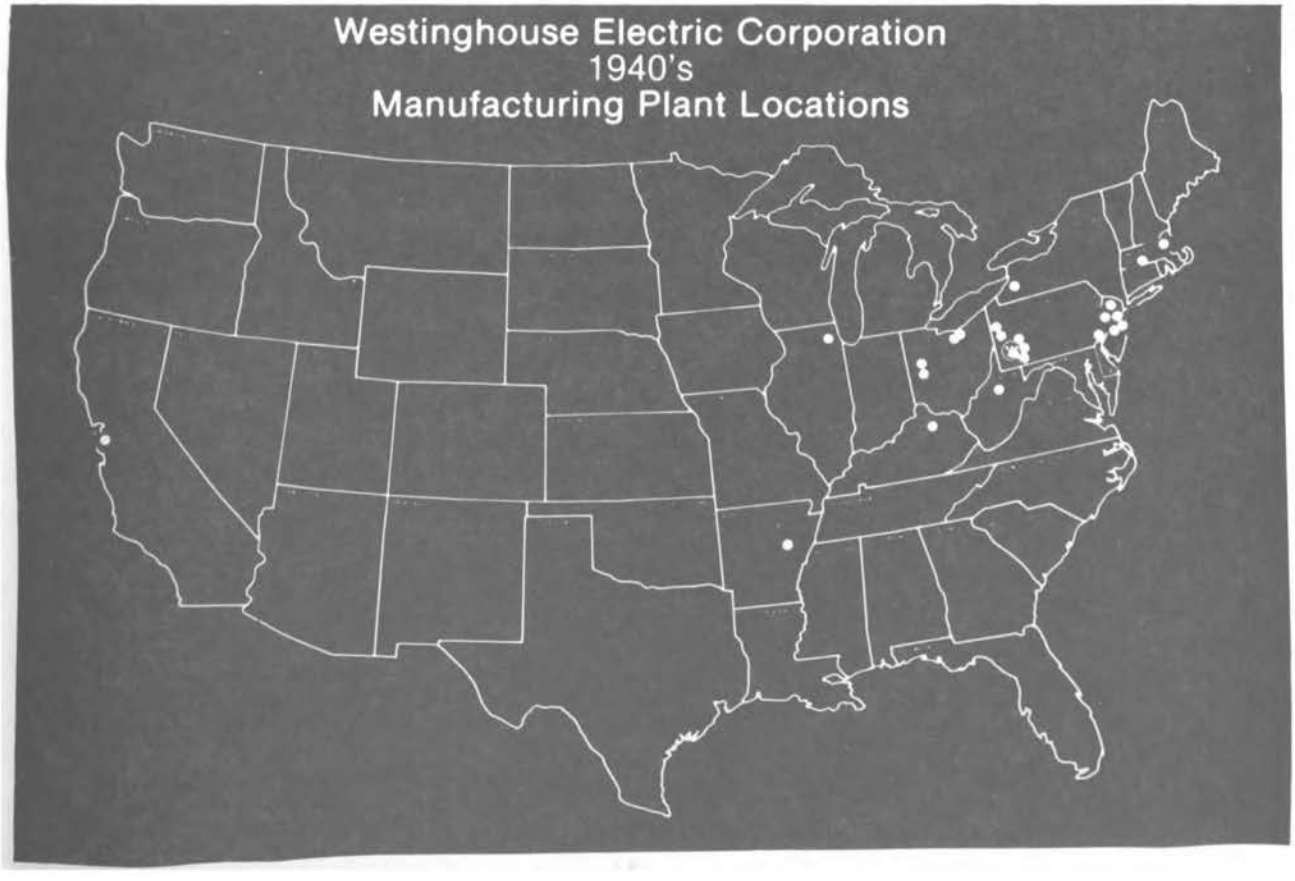


FIGURE 4

From 1951 to 1960, Westinghouse had a second postwar facilities expansion, with 22 new locations being added. Eight of these were in the South (Figure 5).

As the trucklines developed their efficiency through reduced transit time in delivering products, the capability of the railroads to compete for the smaller shipments began to decline. From the end of World War II until 1960, the loss of smaller shipments was so substantial that the railroads abandoned their less-than-carload service. At the same time, many of the decaying freight stations were closed.

By 1960, the share of Westinghouse freight being handled by railroads had slipped to about 50 percent (Figure 6).

As the concept of delivery to the job site was developing--along with the speed of delivery--it became obvious that considerable savings could be achieved in the delivery of consumer products, as well as large electrical machinery and apparatus. The trucklines provided direct-to-customer sale of products without additional costs, such as were incurred for deliveries from the local railroad freight house.

With the greater use of trucks and the large increase in automobile traffic, the federal government in 1955 began the construction of the federal interstate highway system. This system is practically complete today, with approximately 40,000 miles of superhighway in use (Figure 7). This, of course, worked to the advantage of the trucking industry and to the detriment of the railroads. It permitted the delivery of goods in less time and for lower total delivered costs.

In that same year, 1955, Westinghouse concluded some in-depth studies of its transportation needs and decided to begin operating its own private truck fleet. At first, this was on a small scale at the plant level. By now, this operation has expanded to a corporate-wide service, handling approximately 10 percent of Westinghouse traffic on a balanced, round-trip-type basis.

The 1950's also saw the development of air freight transportation as a useful means of distribution. In Westinghouse, the pattern of air freight usage has remained limited to emergency-type shipments and time-sensitive materials. Together, these types of shipments represent less than 1 percent of the overall traffic, but it is obviously a critical part of the company's transportation business.

As a result of technological improvements made to motor carrier equipment, and the development of the interstate highway system, over-the-road carriers gained larger and larger shares of Westinghouse freight business, at the expense of the railroads. For example, consider the case of one heavy manufacturing location of Westinghouse that provides large power generation equipment to the electric utility industry. In 1950, the truckload share of that plant's shipping was 10 percent. By 1970, the truckload share increased to 42 percent.

This significant change in market share was largely ignored by the railroads, partially because our total business was expanding. Although rail market <u>share</u> was slipping badly, railroad <u>tonnage</u> continued to increase. The possibility of getting even greater business was not fully appreciated by the railroads--and perhaps additional business wasn't desired.

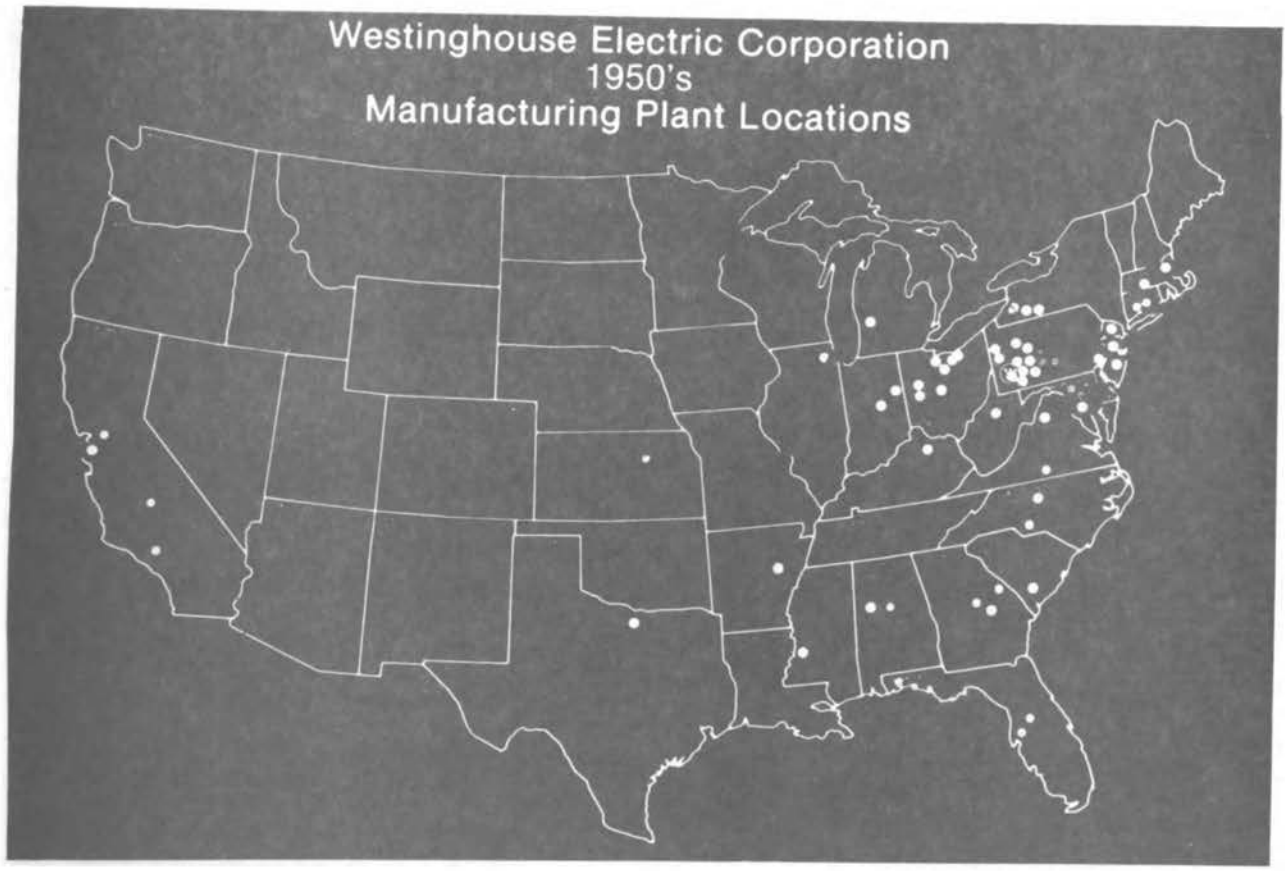


FIGURE 5

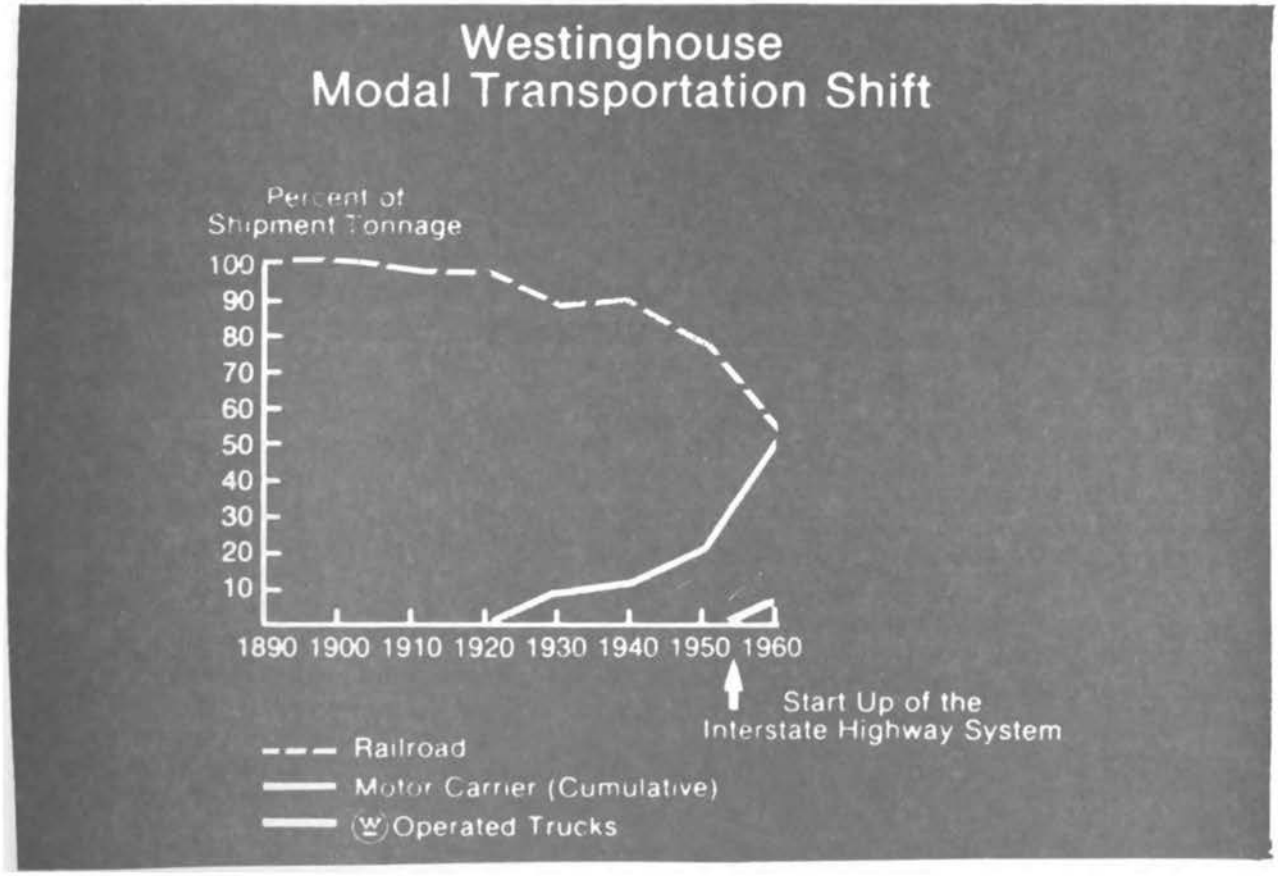


FIGURE 6

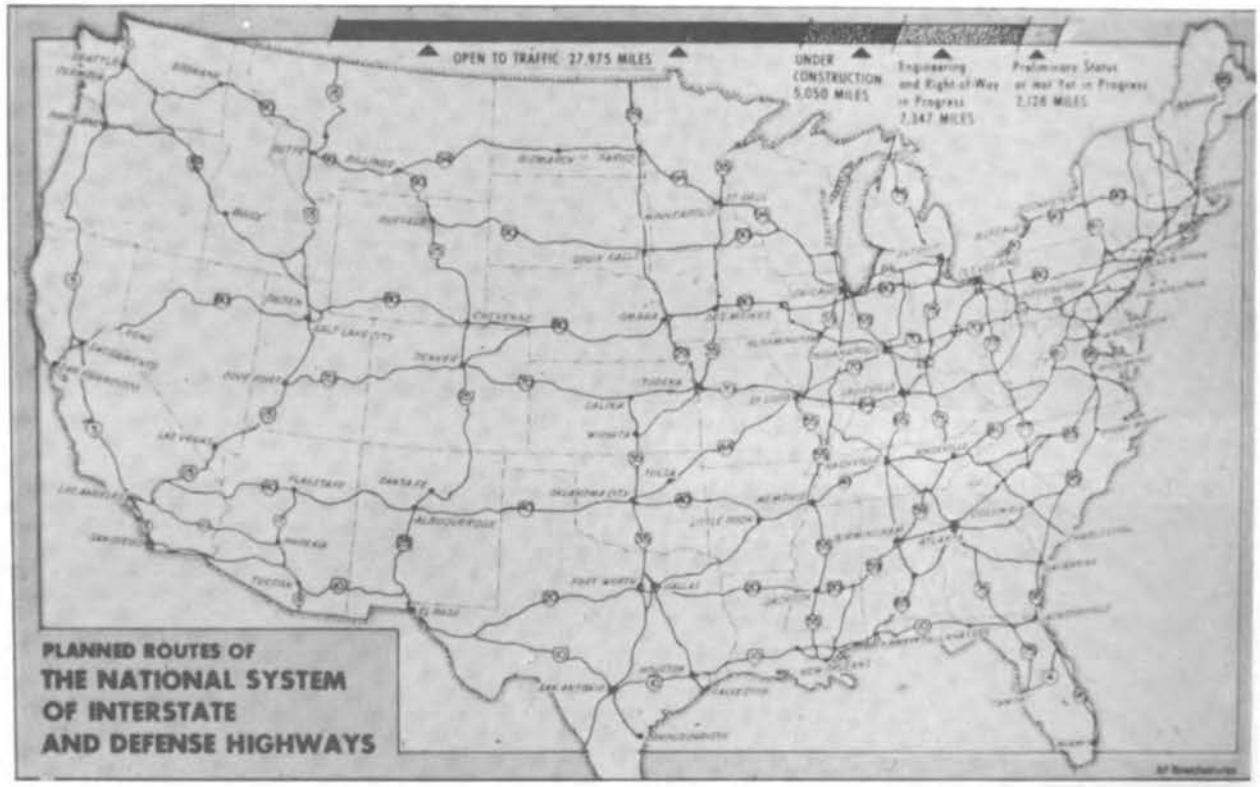

OPEN TO TRAFFIC 27,975 MILES
UNDER CONSTRUCTION 5,050 MILES
Engineering and Right-of-Way in Progress 7,347 MILES
Preliminary Status or not Yet in Progress 2,128 MILES
PLANNED ROUTES OF
THE NATIONAL SYSTEM
OF INTERSTATE
AND DEFENSE HIGHWAYS

FIGURE 7

The Lamp Divisions of Westinghouse show a somewhat similar pattern in modes of transportation. For many years, there was a strong feeling that motor carriers did not have large enough equipment, and that they were not interested in handling lamp products. However, with the increasing size and cube of truck equipment, it became possible for motor carriers to load enough lamp products on a trailer to realize enough revenue to make a profit. As a result, the Lamp Division plants also began a swing from railroads to trucks. In fact, today there are company facilities for warehousing of lamps that don't even have a railroad siding. Years ago, that would have been unheard of.

As Figure 8 shows, the railroads' share of Westinghouse lamp business fell almost 50 percent in the 20 years from 1955 to 1975. In this same period, the physical volume of the lamp business went up over 45 percent. Again, the railroads seemed unaware of the business they were missing, because their total volumes kept going up.

From 1965 on, another modal transportation shift for Westinghouse began. To meet the increasing demands for electric power, the company built power generation products and components in sizes far beyond what had ever been used before. Westinghouse initiative had for a while kept pace with these increases in sizes with the use of the 22-axle Schnabel rail cars. They have a gross shipment weight of 1-1/2 million pounds (Figures 9 and 10).

But when loads reached the limits of size and weight that the nation's railroads could handle, even with the Schnabel cars, the company turned to barge transportation to handle larger shipments. The first water-site shipping location was proposed at our South Philadelphia plant on the Delaware River. Then, in the late 1960's, new plants were located on navigable water in Florida, at Tampa and at Pensacola (Figure 11). This provided the means to handle the complex transportation requirements of the largest power plant apparatus.

The years from 1961 to 1970 marked the third period of expansion in Westinghouse; 27 plants were built or businesses were acquired. The geographical shift in this period was primarily into the South, with the West beginning to get a share of the building (Figure 12). For Westinghouse, this also marked the beginning of a trend to plants of smaller dimensions, concentrating on the manufacture of one product, rather than a multiproduct line. Shipping volume from the new plants was smaller, and the modal shift to truck transportation was even more pronounced.

The period from 1970 to the present saw a continuation of the geographic shift of plants to the South and the West (Figure 13). Twelve plants--among them Jefferson City, Missouri; Norman, Oklahoma; Austin, Texas; Asheville, North Carolina; and Louisville, Georgia--were built in this time period, and the nation's population center continued to move west (Figure 14). While the population and Westinghouse continue to grow, ironically the railroad system is shrinking. A number of mergers have taken place, numerous rail lines have been abandoned, and some fine old railroad names have ceased to exist. This clearly reduces the area where rail service can be used and accelerates the shift to more highway transportation (Figure 15).

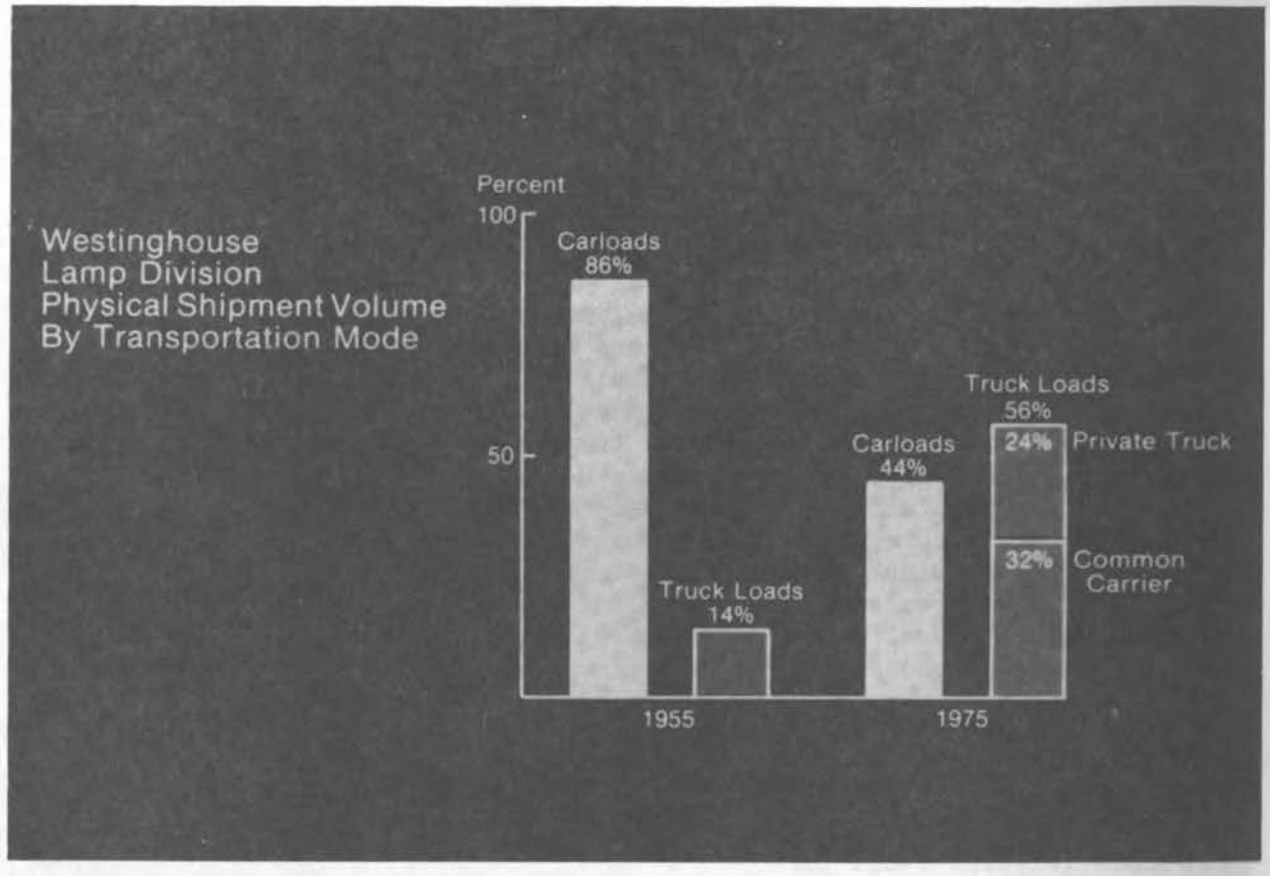


FIGURE 8

FIGURE 9 Schnabel Rail Car

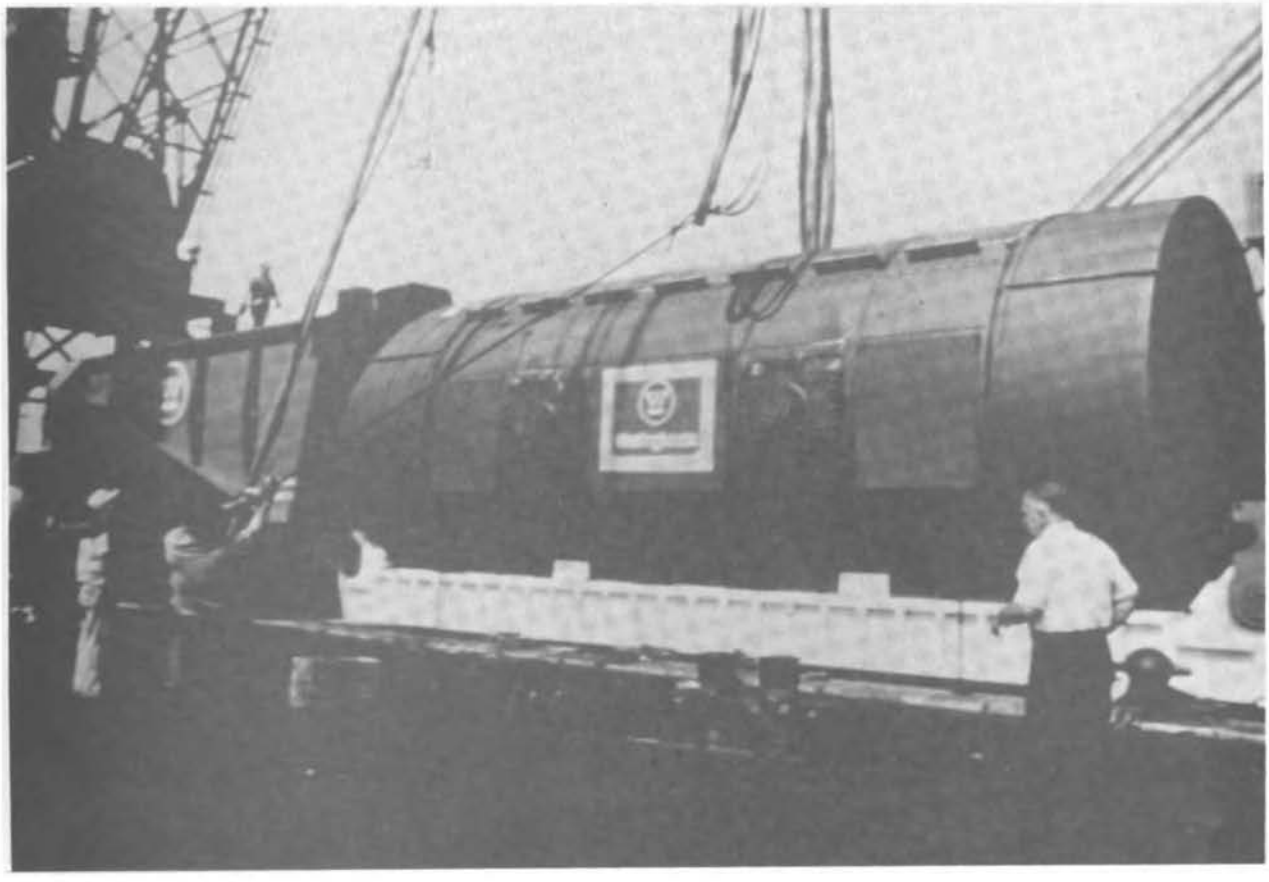


FIGURE 10 Power Generator on Schnabel Car Shipment Weight, 1-1/2 Million Pounds

FIGURE 11 Water Site -- Tampa, Florida

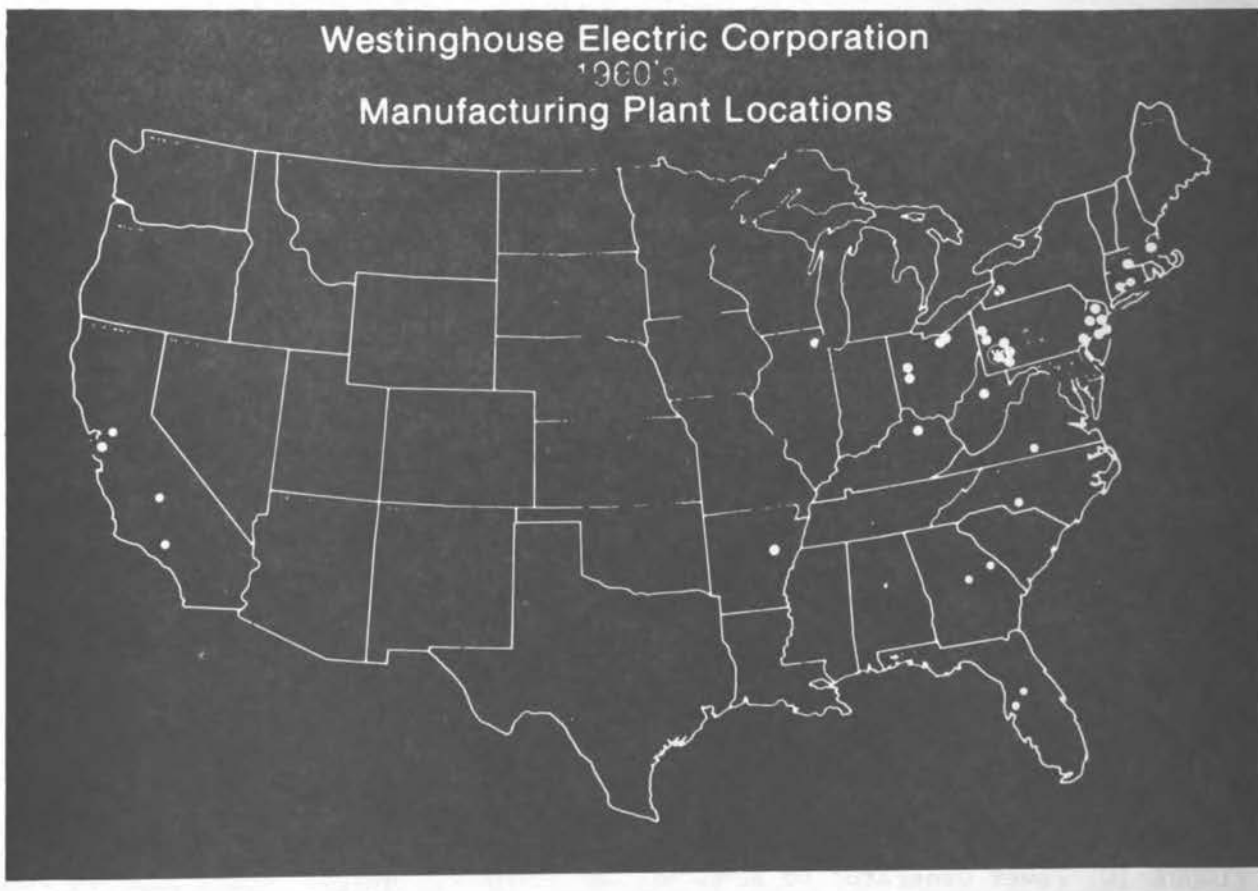


FIGURE 12

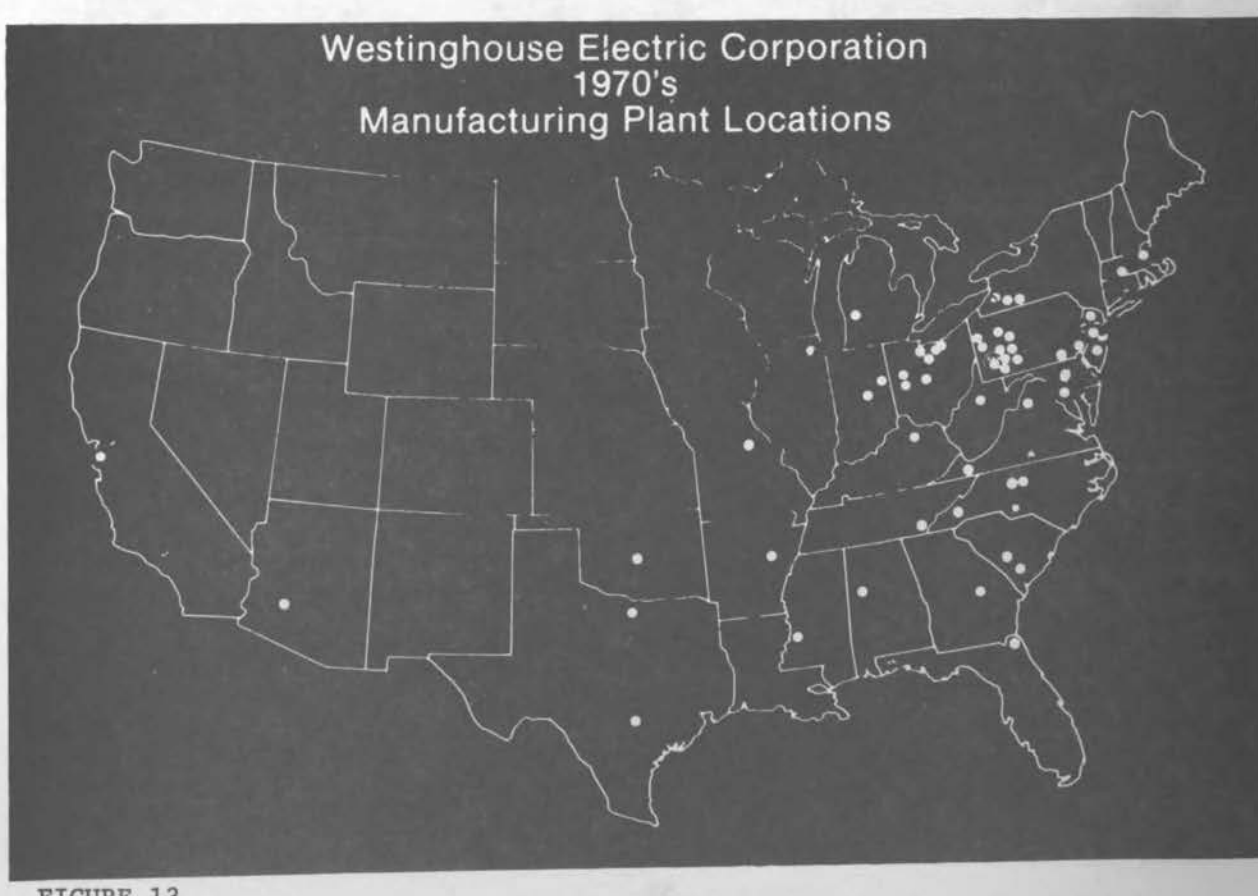


FIGURE 13

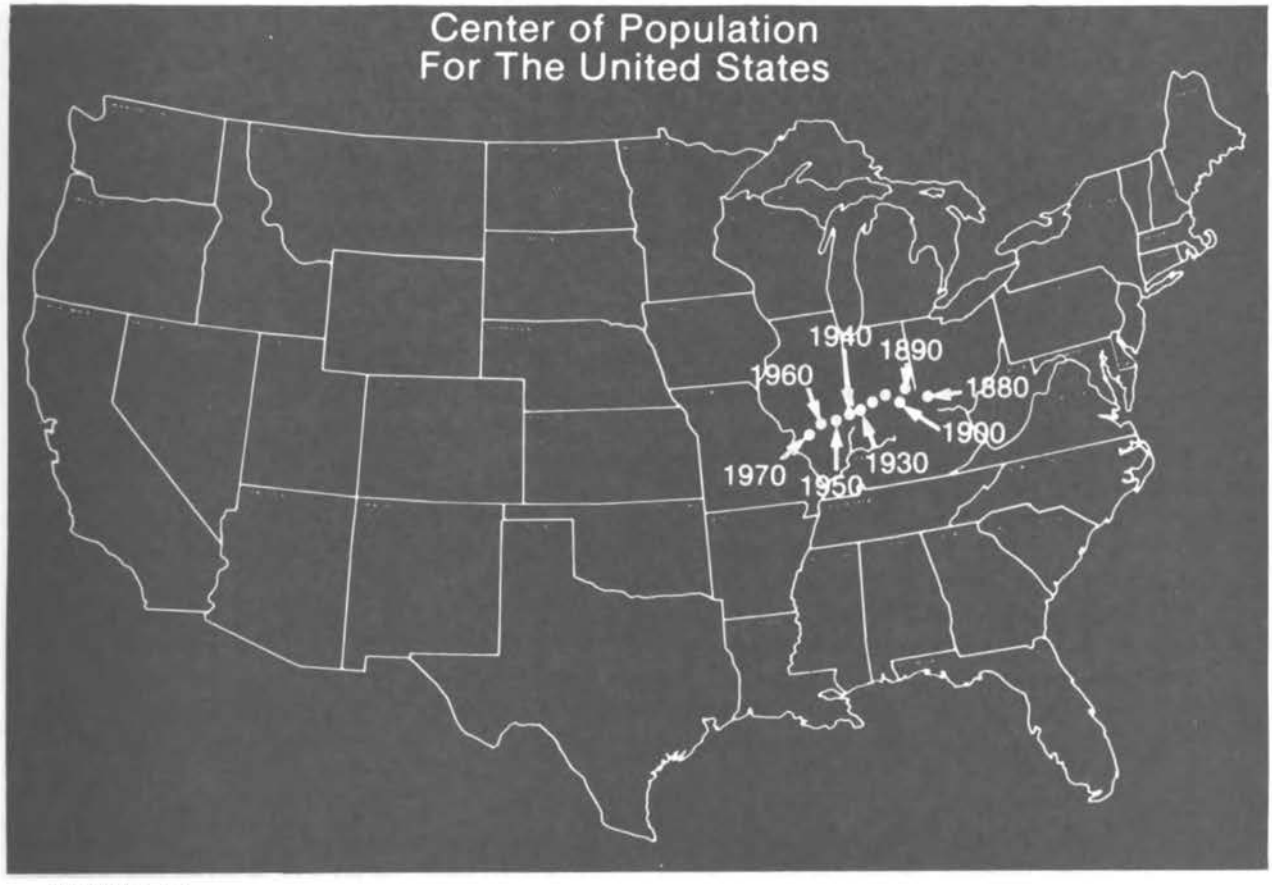


FIGURE 14

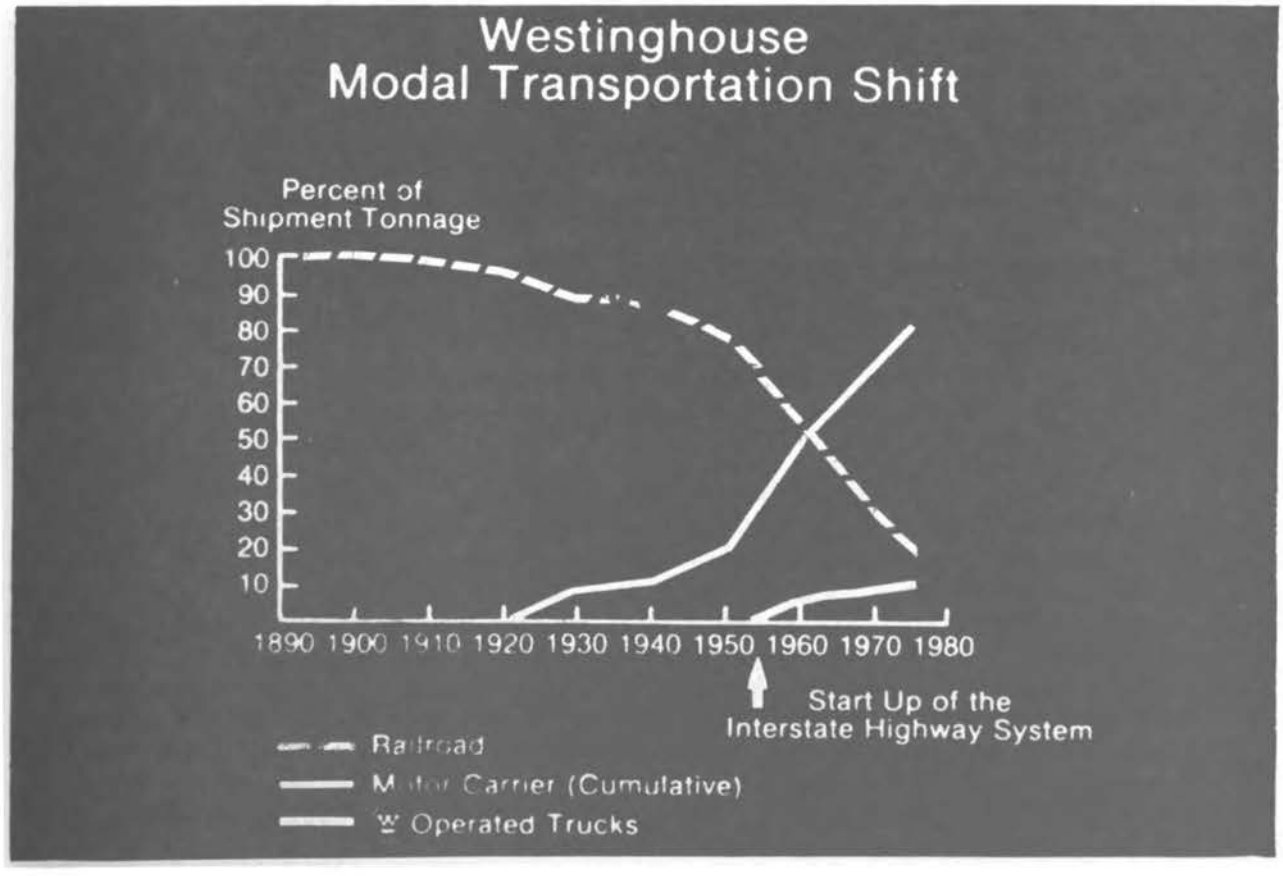


FIGURE 15

As matters now stand, the remaining rail carload freight shipments by Westinghouse consist mostly of lamp shipments to warehouses located 800 miles or more away and heavy electrical machinery that exceeds the capacity of the largest hauler-type trucks.

Aside from rail shipments, Westinghouse and most manufacturing companies today have little practical choice in the mode of transportation to distribute their products. Motor carriers handle the largest share of the shipments and are expected to continue to do so in the future. Whether the motor carrier is a common carrier, a contract carrier, or a private carrier will depend upon efficiency and pricing of their services.

As for the future, I doubt if there is a crystal ball large enough anywhere to give us an accurate insight as to what our patterns of transporting manufactured products might be.

If this meeting had been held on June 12, 1878, instead of 1978, I doubt if anyone there would have had the vision to predict what we now consider commonplace. Perhaps in the years ahead, there may be giant helicopters that will lift one of the huge generators from a manufacturing aisle at East Pittsburgh and set it down neatly in its place at a power station. Maybe, but this is not the time nor place for flights of fancy.

What we know for sure is, that Westinghouse, at least, will continue to be, as it has been in the past, very much dedicated to achieving the optimum in the use of the modes of transportation.

We will continue to be looking for ways to keep the delivery costs as low as possible.

And we will continue to be looking for those means and methods that will achieve the greatest customer satisfaction. That is what has been the Westinghouse history in the use of modes of transportation. I am certain that philosophy will continue. And I am equally certain that Westinghouse will be a good customer for the modes of transportation that are most appropriate for the business and the needs of the companies and industries we serve.

DISCUSSION

DR. MARGOLIN: You inferred that in the last decade or so there had been a shift to the smaller dimension plants, mostly single commodity. Would you say that was primarily due to change in transportation modes, or other factors?

DR. HERWALD: It is related only to the transportation modes. The main reason for the move was essentially cost, and there are, of course, several aspects of costs. Anytime one tries to run a large plant with a tremendous number of products, the operation becomes inefficient because the products are always crisscrossing each other and disturbing the flow. As soon as one can increase the volume of selected items, a plant will stand on its own. For example, Jefferson City, Missouri, builds nothing but underground transformers.

We have a plant in South Boston, Massachusetts, that builds nothing but construction-type transformers; a plant in Athens, Georgia, that builds distribution transformers; one in Muncie, Indiana, that builds large transformers; and one in Sharon, Pennsylvania, that builds medium transformers. Sharon was the mother plant for all of these products at one time. We couldn't come close to doing the volume in all of them, but we have streamlined the operations so that each one of these plants specializes in a certain area, and that is probably as good an example of some of the other things that we have accomplished.

Light bulbs are at the opposite extreme. You can't afford to ship light bulbs very far. Therefore, we began to put bulb assembly plants in different part of the country, starting at Bloomfield, New Jersey, and extending into Kansas and Texas.

SPEAKER: Your charts indicated a substantial growth in private motor carrier operations. In your opinion, is that growth due to a failure on the part of the provider common carrier industry, or is it due more to its specialized nature? And, would it then be most susceptible to either private carriage or contract carrier operations?

DR. HERWALD: First, it was mainly the growth in private transportation, and second, it was the request for that type of service that caused the growth. I don't think it is any failure of the public carriage. They are required to carry all mixtures of commodities. It is really because our volume has grown to the point that we provide loads of one commodity that go point to point. There is no way that one can do better than that, particularly when we usually have some loads coming back from plants going in the opposite direction. Private carriage is only 10 percent of our total, and the remainder (or most) of it is common carrier trucking. The balance is rail, about 10 or 12 percent, a little bit of air, and considerable barging that doesn't show on the charts.

MS. BATTS: I noticed that basically when you were talking about costs of transportation, you were really defining it in terms of total logistics costs. Would you care to make a comment on the models that view transportation costs as simply costs per ton-mile--weight, tons, distance?

DR. HERWALD: I will just take the last part of the question. How often do we view transportation in cost per ton-miles? almost never. We never get it quoted that way. We usually receive quotes in carload lots or truckload lots, or, if it is a special item, the quote is related to that particular commodity on that particular conveyor at that time.

I want to repeat that most of the business decisions we make have transportation as, at least, the fourth or fifth variable of importance. The number one item of importance is what the total labor cost is going to be in the market--not so much due to labor rates--but to modify a plant into a single purpose facility for maximum efficiency. Then with some labor efficiency superimposed on it, taxes become the next most important item. Transportation might be third, usually forth, in the hierarchy of the costs aspects. For many of our products that is not true. Take light bulbs for example. Transportation is a key item there because they are a light, bulky commodity, and transportation cost does amount to something.

I might also mention that we deliberately built some of our plants on the water because the products are so big. There is no way they can be shipped other than by barge.

MS. BATTS: Other than for very large items, what do you see as the future of barge or water mode transportation for your company?

DR. HERWALD: For us it will remain essentially as is, since, for most of our other commodities, we can't afford the luxury of the time water mode transportation takes.

SPEAKER: In the single-product plants, are you shipping nationally or regionally?

DR. HERWALD: The answer is, we do both; however, it depends on the product. The single-product plants ship nationally. In the large transformer plants, where the relative cost of the commodity to the freight is low (all other costs are pretty high), we ship nationally. In shipping light bulbs, where the relative cost of the freight is high, we have separate lamp manufacturing plants in different parts of the country, and therefore we ship regionally.

SPEAKER: Do you use distribution centers, or other types of intermediate consolidation points to gather freight from several different individual plants that are going to a single customer?

DR. HERWALD: Yes, we do.

SPEAKER: Is there a warehousing problem?

DR. HERWALD: We have fewer problems now than we used to have when we were in the appliance business. At that time we had a large warehousing problem. We used to ship to the warehouses. There were five of them scattered geographically. We would ship the right mixture for each appliance plant. We still have that kind of problem, but we handle it in two different ways. One, light bulbs are separately warehoused. Two, industrial products are warehoused and distributed through several distributors. Finally, for the very heavy and large items, we stock in two places--one in the East and one in the West--and ship from them.

CORPORATE PLANNING-- TRANSPORTATION DEMAND, NONDURABLE MANUFACTURED GOODS

A.P. Davis
Assistant Vice President
Carnation Company

I think that in any attempt to project transportation demand into the next few decades, it is vital that we have some input from the commercial sector, the shippers of the nation who are the ultimate users of the transportation system. In fact, that is the reason the freight system has been built. While we may not, as individual shippers, have much effect on the total ton-mile demand, we certainly can influence the portion going by various modes. One of the more important aspects of a manufacturer's business is the ability to move the product from its point of manufacture to the market where it is needed. Transportation is a vital link in the manufacturing distribution process, and, if that link is broken, serious pervasive economic effects are created.

A manufacturer generally has under his control all of the ingredients of his process; that is, the selection of materials to be used, the type of manufacturing process, and the labor force to be employed. In the marketing function he knows what markets he wants to reach, has his marketing plans, and constructs advertising campaigns. But in between, there is the transportation link, and in most industries that link is essentially outside of the industry's control. Most manufacturers depend upon public transportation to move their products and raw materials. That is why its availability and dependability at a proper price is so absolutely essential, not only to the manufacturer, but also to the economy of this nation.

As you have seen this morning, experts are available who can construct models and try to predict demand with the various factors involved. For my participation in this workshop, I want to get down to reality and raise some practical questions that concern my company very much, as well as the industry of which we are a part. I also believe these concerns are shared in a large measure by the industry of this nation as a whole.

There are five general areas of concern to which I would like to direct attention. I believe each of these categories will have an impact of substantial magnitude on the nation's transportation demand for the next few decades. These are: (1) quality of the service to be rendered by the carrier, (2) the regulatory reform measures, (3) the availability of investment capital and competition for its use, (4) the growth of private carriage, and (5) the impact of the projected shortage and use of energy.

My comments on these subjects will be limited to rail and motor transportation, where I think the impact is likely to be most severe.

On the matter of quality of service by carriers, I believe most buyers of transportation would rank dependability in transit and delivery time as a very high priority. In the management of most manufacturing businesses, it is fundamental to the financial success that inventory of raw materials and finished goods be carefully controlled. That inventory generally represents a major part of the investment in the business, and its turnover is vital to earning an adequate rate of return. Maintaining any level of excess inventory over that which is essential to support sales represents a nonproductive asset that a well-managed company will not tolerate.

There is no question in my mind that attention to inventory control is going to sharpen. Computer technology is already here to assist in that sharpening process. For example, in the grocery industry, we soon will have our customers' computers talking to our company computers and handling the order entry, the scheduled processing time, the in-transit time, the payment scheduling and transfer of funds. But inventory control underlies this whole process, and this will make it mandatory that the transportation mode used be dependable, for any vagaries in the transportation model will upset the entire cycle.

In the grocery industry, a lack of dependability by the transport modes will cause a shift from one mode to another. A shift from rail to motor carriage has been under way from some time, as evidenced by the market share statistics that are well known.

The dependability of railroad service at the present time leaves a great deal to be desired. In comparing rail and motor carrier service I am speaking broadly when I characterize railroad service as poor. The shippers of this nation are receiving far less in dependability in rail transportation than they are entitled to or their businesses demand. There simply must be a better way for the railroad industry to handle the dislocations that we are presently experiencing. A whole paper could be prepared on that. Unless service improves dramatically, rail carriers will lose a greater market share at a much more rapid rate than they have experienced in the past.

We may project transportation demand and allocate resources by modes for the next decade or beyond; but, if one mode fails to perform, I can assure you that the allocation will change rapidly, and any future planning must take this factor into account. We must keep in mind that in our railroad system we have no overall policymaking body that is capable of directing the industry as a whole. Unlike the rest of the world, our rail transportation system is comprised of individual companies, each of whom makes its own policies, not always motivated in the same direction or to the same ends; and, in varying degrees, each may be propelled by parochial interests.

So, if rail is a part of the process in a movement from point A to B, a manufacturer has to be concerned with more than one carrier, and that leaves a much greater margin of error in failure to perform. That is not the same situation as with motor carriage. Most truckload shipments and, to a large extent, less than truckload shipments move from

origin to destination by one carrier under the control of one management for overall performance.

In a situation where there are competitive transportation modes, as in the case with most manufactured goods, continued service failures by rail will inevitably lead to a shift in modes. Unless changed, this will lead to a greater market share for the motor carriage industry than would otherwise be projected simply by looking at past data.

On the matter of regulatory reform, the direction that reform takes in the next few years is another factor likely to have an impact on the allocation of traffic between modes. The Railroad Revitalization and Regulatory Reform Act that was passed several years ago, if analyzed objectively, will show, I believe, that not too much benefit to date has been realized by the rail industry or to the shippers they served. I don't believe any discernible change in demand can be attributed to this legislation. To correct some of the particular measures that have proved to be less effective than Congress desired, perhaps some further legislation may be proposed. But if past is prologue, little effect on demand is likely to result.

On the other hand, what Congress does in the matter of motor carrier reform could have a beneficial effect on that mode. There is a large body of traffic on which the railroad industry until recently was competitive, but is not now competitive. That tonnage is now being handled by motor carriers. This is what basically underlies the growing market share for motor carriers and the declining share for railroads during the past few years.

At present prices, there remains another large volume of traffic on which the railroads are now only marginally competitive with the motor carriers. Most of this traffic moves in the range of 500 to 800 or 1,000 miles. Some of the proponents of motor carrier reform allege that present regulation adds hundreds of millions of dollars to motor carrier costs. As a by-product of reform, they are predicting a decline in motor carrier costs, and a corresponding reduction in freight rates to the shipping public. Should there be a decline of about 10 percent, which some say is not unreasonable, then there would be a very substantial shift of more tonnage from rail carriage to motor carriage.

Granted, some of this is speculative, but, if entry controls on motor carriage are relaxed and more competition injected into the business, a decline in prices is certainly conceivable. Such a shift, along with the shift due to service, will call for a reallocation of resources that will be necessary to handle the growing problems of highway congestion, construction, repair, and so forth.

In the United States, it is said that there is now one truck on the highway for every eight persons, a startling statistic. When one looks to the future and sees what I believe to be an inevitable shift toward motor carriage, the attention that his nation must give to its highway program becomes very evident.

Since our common carrier system is still, in the main, privately operated, the question of availability of capital is one that has a very direct effect on transportation demand. In our capitalistic society, investments are made based on the return that one can expect. Industries

that do not earn a reasonable rate of return when competing with other available investments will not attract capital to support that industry. Requirements, not only for locomotives and cars, but also for track and right-of-way, maintenance, repair, yards, depots, and signal communication equipment, call for expenditures that can be considered huge. Periods of inflation, which we have been experiencing, add tremendously to the capital burden.

Road haul locomotives now cost about $600,000 apiece. The simplest ordinary boxcar approaches $30,000. The railroad industry right now is earning a very low rate of return on investment, whether one uses the ICC or standard accounting principles. This has been the history of the railroad industry, at least for the last decade; and, while there are some companies within the industry that do well, there are others that have negative returns. Any forecasting of transportation demand must take this very dismal fact into consideration.

It is true that the motor carrier industry is also capital-intensive, but its capital is required essentially for tractors and trailers, the operating equipment, terminals, and, to a lesser extent, communication. But there is one vast difference between these modes that is the key to the future ability of the railroads to hold the declining share of market that it now has. That, of course, is the difference in equipment utilization between motor carriers and railroads. The key to return on an investment is rolling equipment, its efficiency of utilization, and the availability of such equipment for earning capacity. I can think of no investment that is more underutilized in all this nation than the railroad fleet of freight cars. They are producing something less than 10 percent of the time. Unless utilization is improved substantially, and very quickly, the erosion of general merchandise away from the railroads is inevitable.

We have a declining car fleet. It declines each year, and right now there are shortages in just about every segment of the business--boxcars, hopper cars, refrigerated cars, piggyback trailers, flatcars--and these shortages seem to be unending. The answer to the problem lies not in acquiring large numbers of cars for which the capital is not available. However simple it may seem, effecting even a slight increase in utilization seems hopelessly unattainable.

On the other hand, the motor carrier fleet utilization has improved dramatically over the last decade because of lighter weight trailers, heavier payloads, and increased highway speed. There are further improvements in motor carrier equipment utilization in the offing, through change to increased lengths and weights and through the growing trend toward hauling double units.

So when competitive modes compare utilization, and in one mode utilization is poor and getting worse, while in the other mode it is good and getting better, it is not difficult to predict results--insufficient earnings by railroads to support additional investment and the direct opposite for motor carriers.

That is not to say that there is no investment of capital being made by the rail industry, but a major share is going for road construction and equipment to improve the railroads' ability to haul the coal

that is being forecast. The growth of the availability of coal to the railroads does call for extensive capital investment, and the rate of return from this investment in unit trains may be greater than for general commodities. So the manufacturers of durable and nondurable goods must compete within the rail industry for available capital, and under this state of present railroad operations, coal is going to be the winner. I hear it repeatedly said by railroad executives that they cannot afford to buy boxcars.

There is a trend towards shifting some of this capital burden to shippers and manufacturers by encouraging them to furnish their own cars. This trend is going beyond the traditional tank car and covered hopper. Whether this is successful, and whether it will be helpful, depends upon the return that the shipper is going to expect for this investment. Compensation for private cars must be paid out of railroad earnings somehow, and much of the car hire expense is going to be borne by railroad companies who are least able to pay. So overall, from the standpoint of investment capital, this shipper's view is that the failure to earn sufficient to justify investment by the railroads will cause a further shift of tonnage to the motor carriers.

Much has been said about the energy problem since the crisis began several years ago, and you heard quite a bit about it this morning. In the years to come, no doubt, greater weight will have to be given to this factor. The allocation of transportation to the most efficient energy consumer is a great advantage to the railroad industry. That is true not only because of the energy shortage, but also because the energy cost increase per-unit cost of moving freight will certainly be greater for motor carriers than for railroads. But energy is only one part of the resource allocation equation.

While energy efficiency favors the railroads, the effects of transit time, reliability, and equipment shortages that cause manufacturers lost sales and increased inventory investment are likely to outweigh the energy benefit that the railroads have. If the railroad industry could solve the capital problem and correct service deficiencies, energy utilization advantages would, in my opinion, assure a reversal of the unfavorable market share trends. However, there is little evidence that this is likely to happen. The energy crisis by itself will not change the long-term trend line.

There is little doubt that private over-the-road carriage among the nation's manufacturers is the fastest-growing segment of the transportation business. Most manufacturers are starting private operations at a fast rate. Most private truck operations can be considered quite successful, and those who have invested in this business are realizing an adequate rate of return.

This is a very ominous trend for both the railroad and the motor common and contract carriers. Most importantly, private carriage falls within the complete control of the manufacturer, giving him that assurance against a break in the manufacturing distribution cycle to which I have previously referred. This incentive for private carriage cannot be overlooked.

Another factor that encourages growth of this type of transportation is the shift of capital burden for rail equipment from railroads to

shippers. A shipper in many cases now has the choice of furnishing railroad cars through ownership or lease, or expanding his private fleet. In the face of poor utilization and undermanagement of the railroad fleet, an extensive investment in private cars means the manufacturer would be underwriting poor utilization. A more attractive alternative certainly is found in an investment in tractors and trailers.

There is not too much discernible effort being made by the public carriers to combat this ominous trend. To some extent, the efficiency that private carriers offer is being frustrated through such strained devices as the prohibition of intercorporate hauling now being enforced. I believe it is fair to say that this kind of regulation is likely to be changed by administrative process. The present thinking at the ICC seems to favor more freedom from artificial restrictions. This is evident in a recent change in the long-standing decisions that have prohibited dual operations by private carriers. This change in regulatory attitude will undoubtedly encourage the growth of private carriage, and many manufacurers will take advantage of the efficiency inherent in carrying one's goods.

The thrust of my remarks has been directed so far toward the declining railroad situation, which I see as a major factor in any long-range planning for transportation demand and capacity capability. That is certainly true in my industry.

While this presentation is pessimistic about the future of railroad transportation, forecasting demand should take into account that bulk commodities, especially coal, chemicals, clay, and basic raw materials, will lend themselves to rail movement, particularly over long hauls. However, one cannot ignore the fact that our privately owned railroad system has not been earning sufficient profit to support the heavy capital investment that that industry requires. This suggests more government involvement in that system, and the movement in that direction is quite clear and under way.

First, do not forget that ConRail, just a few years ago, was five separate railroad systems. At least three major railroad systems in the Midwest are now supported by federal money. Another one is seeking capital in huge amounts for the development of its coal-hauling ability, and, just a few weeks ago, one of the largest profitable systems in the country announced it expected to seek up to $200 million from the government, again to be used mostly for coal-hauling development.

I am not alone in voicing alarm over these developments, for they portend a definite drift toward nationalization, and I do not view that as an acceptable solution to this nation's transportation problems.

One major railroad system advertises extensively that, when the growth in ton-mile transportation demand comes in the decades ahead, that carrier will be on top. I don't doubt that will be true for one carrier in the limited geographical region it serves. That is by no means, though, likely to occur throughout the nation as a whole.

All of this seems to make one thing more certain to me: While there is a current trend quite evident of more manufactured goods moving by motor carrier, in the years to come there will be a substantially greater shift in demand from rail to motor carriage for the very large

tonnages of nondurable goods. This is a major consideration in our national transportation planning.

DISCUSSION

MR. TERRY: When you were talking about rail service and consistency of service, you seemed to say that part of the rail problem was its interline service. In line with that, and with what you mentioned about the overall rail situation, do you think rail mergers with more single-line service potential on the part of the railroads would be a help or a hindrance to avoiding nationalization?

MR. DAVIS: I think probably a merger movement would be a help in avoiding nationalization because of the strength that it would give to the carriers and the removal of some of the opportunities for service failure. As I said, there are individual companies involved in this transportation system with no overall responsibility for movement. In the interline movement from railroad to railroad, there is a great deal more opportunity for failure to meet anticipated arrival time by reason of the number of yards, connections, missed trains, etc. Generally speaking, I think the merger movement would probably help the railroads.

MR. GORHAM: Do you think the time has come to remove the barriers in multimodal transportation companies?

MR. DAVIS: Yes, I think we ought to remove the barriers to multimodal transportation systems and open it up for competition. I think this would help.

DR. HERWALD: I would like to comment further on the ills of the railroads. It would appear to me that if the railroads could operate more like the truckers with run-through trains, thus reducing the delays inherent in the making up and handling of trains, their future would look brighter. Do you see any trends of that nature in the future?

MR. DAVIS: There have been some moves toward run-through trains to improve service and to cut down on the number of instances where cars must be classified. That has been an improvement via run-through terminals. However, it still remains today that there is a substantial amount of traffic being moved through these same terminals for breakdown that I don't think can be avoided. For example, if you have a block of cars running from California and they are destined for New York, you can do a pretty good job on the route. But suppose you have one going to Waterloo, Iowa, and another one going to Biloxi, Mississippi, and another one going to Omaha, Nebraska; you don't have a very good opportunity to make run-through trains in all of those directions. That is just one of the practical problems of this type of operation.

DR. HERWALD: If you put that together with your multimodal company, though, you begin to solve that problem.

MR. DAVIS: That is correct. Putting it together with a multimodal company may begin to solve that problem.

SPEAKER: If the shift to trucking occurs, what kind of moves and commodities would Carnation shift from rail to truck?

MR. DAVIS: We have already converted a substantial number of truckloads of canned evaporated milk. Everybody is familiar here with that product, because if you all have beautiful children you raised them on Carnation evaporated milk. We have a large volume of Carnation evaporated milk that is shipped to wholesale grocers around the country, and here we have made a major shift from rail to motor carrier, and there will be others. We are in the business of moving a product from the West Coast. Presently, most of that moves by rail, but there is substantial motor competition for this business. In the East, between our plants and distribution centers, there are great opportunities to move our pet food products by motor carrier. This gives you some examples of what can happen.

DR. BENTZ: You gave us a feeling for the relative decline in the rail system. I would like to ask a question directed to that decline. What prognosis do you foresee as the penetration of automation into the rail industry in the future? What effect do you think it would have on the railroad's ability to achieve a more healthy vitality in the future? And, what major barriers do you see in the introduction of these automation effects?

MR. DAVIS: I don't know what specific automation effects you are concerned about, but I do have something to say about the effort to get a national car identification system fed through a national computer that would help considerably. As you know, that failed. I don't know all of the reasons for the failure, but that seemed to be an experiment in the right direction. One of the problems a shipper is faced with is trying to maintain the continuity of movement over several railroad systems, and at the present time he has to deal with each segment of the route to monitor the movement. What are the barriers to that? I think one of the barriers is the parochialism that exists in the railroad industry and the fact that we do have an industry made up of so many different companies, each having different ideas and different views on how some of these things should be accomplished. I think that is the definite detriment to industry's use of that kind of technology.

DR. MARGOLIN: As you know, more emphasis is being given to intermodal transportation. What is your view of the prospects for the future for intermodalism as reflected in TOFC and COFC?

MR. DAVIS: I think that has certainly had a beneficial effect on the railroads, but, as I see it now, we are running into the same difficulties with TOFC and COFC that exist with regular boxcar movement; that is, a shortage of equipment and the associated capital problem in getting equipment as well as the proper utilization of the cars. Along with the railroads' difficulty with balancing movements in both directions over long distances the railroads have been running piggyback trains on faster schedules to try to compete with the motor carriers, and, of course, this will help. However, we are faced again with the situation of major capital investment for equipment. For example, we have a situation in the Northwest right now, where we are having difficulty with frozen potatoes. There is a dearth of available equipment

for this type of movement. We are in the process of discussing forming a shippers' association in order to get the equipment together that is necessary for this shipment. It is part of that shift of capital burden from railroads to shippers that I mentioned earlier.

MS. BATTS: When you were discussing energy, you seemed to make the assumption that rail was *ipso facto* more fuel-efficient than motor carriers. There seems to be a question as to whether that is true, particularly with all types of railroad dispersement. Why don't we get down to specific levels, corridor by corridor, or commodity by commodity?

If the studies that are being planned and that are going to be run this fall and this winter comparing actual movements prove, indeed, that there is a trade-off between energy efficiency on motor carriers and railroads, what will be the future of railroads if they are not running at the efficiency of motor carriers?

MR. DAVIS: If it turns out that the rail carriers are not more energy-efficient than the motor carriers, what is the future? Bleak, I think, to give you a straightforward answer, if that turns out to be true. I did make an assumption that over long distances, moving long trains, that there is an energy-efficiency benefit for rail carriers. I think there is. You may have some studies that show me wrong. But energy efficiency is one of the pluses for railroads.

I think in the future we will be trading even energy efficiency in order to get some of the other things that we must have, such as dependability of service and control of this inventory expense, and being able to have milk on the shelf when we go to the store to buy it.

MR. MORITZ: Have you in Carnation done any investigation internally to estimate what you would shift to private carrier, if your intercorporate barriers would permit?

MR. DAVIS: None, because we don't have any intercorporate barriers. Our structure is such that we don't have subsidiary companies, so we are in a position now to haul by private carriage whatever the Carnation Company makes.

DR. BENTZ: You mentioned capital availability as one of the key concerns for the railroad industry in the future. I would like to ask a trend-based question for the nondurable goods area. We note that in the coal-moving area, most of the purchases of boxcars, rolling stock, have been by the shippers in recent years, particularly the utilities. What do you see as the trend in the nondurable goods area for this source of capital for the railroads?

MR. DAVIS: The trend in many areas is for the shipper to furnish his own cars. We have a difference in philosophy between railroads now. There are some individual railroads that actively encourage a shipper to provide his own boxcars for moving canned goods, for example. There are some carriers who are encouraging us to do that and they will adjust the rate to compensate for this.

Other carriers don't feel that way about it. They think it is part of their responsibility to furnish the equipment. But looking at the railroad industry as a whole, the cost of this equipment is escalating rapidly. I said $30,000 for a normal boxcar, and if you want some load-restraining devices in it, as we do for the movement of 125,000-pound

loads of canned goods, then you are talking $45,000. And the present utilization of that equipment is so poor that you don't have to be very smart to find out that that is a very poor investment.

Our alternative, then, if we want to move by railroad, is to supply that equipment ourselves. Our decision then is, are we going to make a capital investment or are we going to undertake some long-term lease of equipment? We then put that cost on one side of the ledger and see how the numbers turn out, and on the other side we put the cost of our private carrier operations. I don't think you need a computer to figure out which way you would go on that situation.

In our case, we have leased about 300 rail cars over the past 5 or so years. We are not going to do that anymore, because I don't think the economics are there for us long term. That is what worries me. We are alright where we stand now, but making further commitments in this way seems to me to be very risky on our part. We have a problem with the compensation. If we don't get a reduction in the freight rate, we have a problem with the general level of compensation that is being paid by the carriers--it is not sufficient.

We want the carriers to increase that level of compensation. The carriers are up against the same problem as they would be if they had to invest it in themselves. Compensation has to come out of their earnings somehow, and they are not earning enough money to pay for the cars.

DR. HERWALD: The point that you are making is a critical one, i.e., that everybody who is in business is looking at the return on investment, even more so as you get inflationary, because money just costs more. If you look at the problems of noncompetitiveness in the railroad, they really fall into three categories. One is the superimposition of regulations left over from the days when railroads were monopolies, to a great extent, that prohibited them from doing certain things.

Another category you touched on is that the railroads are far behind in the use of available technology such as in the car identification area.

The third one is the work rules that the railroads have inherited from times when trains went short distances and had to be broken up, etc. I put all three of these items into the category of getting more productivity out of the equipment, and, therefore, hauling the commodities that are profitable to the railroads to haul over certain distances, and then breaking the cars up and doing the local deliveries by truck.

I don't know whether you have looked at that scenario at all from Carnation's standpoint, as to how you do that. But, at least in my mind, unless the railroads begin looking in that direction, or are allowed by the government to do it, they are going to go down the drain.

MR. DAVIS: There is certainly some merit to that. We are going through a process of trying to determine which business, long term, is going to lend itself to rail haul. Certainly the shorter distance movement is not, and certainly lighter loads are not. These are the two conclusions that are rather inevitable. If you take a carload of freight, and you load the maximum weight in a boxcar, say 130,000 pounds, and move it 3,000 miles, that is rail tonnage. But that isn't the way grocery products move by and large. That is the big problem. We have

some commodities that move in only 40,000-pound loads, and that does not lend itself to rail carriage. They are giving that up to the motor carriers.

I don't really know that this is all a regulatory problem. Sure, there are some regulatory problems with the railroads, but I don't look upon that as being a major inhibition to some of the things that ought to be done. I frankly think that has been too much of an excuse over the years for failure to innovate. And that, of course, hopefully will change; the attitude, certainly down to the commission, is to give more latitude to independent judgments by the carriers rather than by the regulator. You have generation after generation of people who are used to thinking in that way; they have to make some big changes.

MR. TERRY: Other than the fact that it might be a subsidy to the railroads, do you see the government owning the right-of-way and fixing it up, and then charging it back to the rails as any part of the solution to their problem?

MR. DAVIS: I just don't see having the federal government in the ownership of rights-of-way, and then beginning to make the decision to which railroad uses it, and what trains use it, and all that comes with it. I happen to be very opposed to government meddling in the operations of private transportation systems. I just don't see that as a solution. There have been some studies made on that several years ago when this was up as a possibility, that convinced me that this is not a viable way to go. It is just one more step down to having a Canadian National system.

Now, if I may respond to an earlier question, which was: "You have been talking about finished products, what about raw materials?"

To a large degree the same thing is true now. We have some raw materials that move in very heavy quantities--grain, for example, and ingredients in pet food or in animal feed--moving long distances from Nebraska to California in 100-ton lots. That is long-term rail business. But we are now moving large quantities, for example, of tin plate into our can manufacturing facilities by truck. Practically all tin can movement, which is an ingredient, is a truck movement now.

So generally, what I said about finished goods also applies to raw materials in our company.

MR. HAAN: It seems to me that one of the things we should be looking at when we are trying to forecast, and the way we should evaluate different traffics, is to actually make a sort between manufactured durable and nondurable goods and bulk products. Perhaps in making such a division and then forecasting on those two bases, we will find a different need for the railroad than we find when we look at it for all commodities.

As an example, I heard the statement made that the railroads have no place in short haul, and that is exactly contrary to our experience when we are moving phosphate rock in trainload quantities 20, 40, 50 miles. We move in the industry 55 million tons this way, and truck can't begin to compete with a trainload concept in short distances when it is that type of commodity.

So perhaps one of the things that should be done when we are trying

to forecast is to make that division. What do you think?

MR. DAVIS: I think that is a very valid point, and I think that is a natural division. Perhaps I alluded to that somewhat in what I said, because there certainly is a place for the heavy movement of bulk commodities, as you point out, in trainload lots even in short distances. That is a very valid observation. I suppose if you were forecasting in that way, you would get quite a different answer than if we lump everything together on a ton-mile basis and project that. I think you are absolutely correct in forecasting that way.

MS. BATTS: It is interesting--we have taken one-half of the equation and said you really can't look at it on a ton-mile basis. I wonder if you can't take a look at the other side. We find that all rail is being categorized as a homogenous group, and it appears that there is no such animal called "all truck," and there is really no such animal called "all rail."

When you start breaking them down, is there really such a thing as the railroad industry? Is there really such a thing as the trucking industry? Isn't there the private carrier industry, and the western truckload, and the truckload? You then shuffle the deck harder, deal it all over again, and you start making a projection of ton-miles for truck. Are you then coming up with a horse that nobody can ride?

MR. DAVIS: The question is, if you take ton-miles as the guide without any sub-breakdowns, both by rail and truck, are you coming up with a horse that nobody can ride? I think to a degree you are. I heard the question asked this morning to a previous speaker, I think: "What use do you make of ton-mile statistics?" He said, "Zero." I would say the same thing. They mean absolutely nothing to me. I want to know, as does every manufacturer, what it is going to cost to do the particular job that I have in front of me by the various modes, and ton-mile costs don't enter into it at all. They may be a guide that shows trend lines, perhaps. I am not even sure of that. But from a shipper's standpoint, I don't think ton-mile earnings or growth by ton-mile is a very meaningful thing. Because we talk about the ton-mile available for railroads, a great deal of that 20 years from now is going to be in all this coal that is coming on. That is a ton-mile, the same as my can of milk moving is a ton-mile. I think you get vastly different answers if you look at those two segments.

MR. HAAN: Again, I think you get a different viewpoint depending upon which of those two categories I suggested that you find yourself in. I suggest if you find yourself in the bulk product, for instance, mined products, which have low value, you are not in a value-of-service type of thing, you are in a ton-mile business. And it is very, very significant to us. Again I say that is why, perhaps, that division between the kinds of traffic, between bulk-type traffic and manufactured durable and nondurable goods, is one that should be a threshold question when you are going into forecasting.

MR. DAVIS: you get a different view between a nondurable man and a durable man. And rightly so. I agree with that.

DR. BENTZ: I just have another question on the nondurable areas, a rather broad question. Many people have felt that the nondurable

goods, particularly the grains, will provide a great deal of export revenue to the United States in the years to come as a food basket for the world. The question I have, from your experience in the nondurable area is, do you feel that the existing transportation infrastructure, right-of-way, port facilities, and such, intermodal facilities, are adequate at present to handle these projected export crops?

MR. DAVIS: I will defer that question to my friend, Jim Springrose, the next speaker, who knows a lot more about exporting grain that I will ever know, and perhaps he would be better qualified to answer that question. I don't have any particular experience with the ports in handling bulk, except in a very narrow area.

CORPORATE PLANNING--
TRANSPORTATION DEMAND,
BULK COMMODITIES

James V. Springrose
Vice President, Transportation
Cargill, Inc.

Before I begin my semiprepared remarks, I should make a distinction between Westinghouse--they are not unique in relation to other durable and nondurable manufacturers--and Cargill. The distinction is that transportation expense is the major element in the cost of running a business like Cargill, where that is not the case at Westinghouse. In reference to Al Davis' comments about conversion from rail to truck because of poor rail service, I am pleased that they are shifting their durable and nondurable goods shipments off the railroads. That should cut down on some of the congestion and allow better service for our goods that we need to move quickly.

At the outset, I want to express my sincere gratitude to a young man, Andreas Aeppli, who was a student intern in my office, and who devoted much of his time and talent to the research that underpins my remarks today. Without his valuable assistance, I doubt seriously that I would have found time to participate in this workshop.

Even with his help, and with no discredit intended toward him, I must admit that I approach this topic with trepidation, and even almost intimidation, and for what I think are two very valid reasons. Our corporate analysis and the resulting forecasts of demand for freight-carrying capacity of whatever mode, have historically fallen dismally on the short, or the conservative, side of reality. Secondly, the reliability of the fundamental data necessary for better forecasting is suspect for various reasons, because it becomes a forecast of global food supply and demand.

In this vein, I speak primarily of the grain export marketing pattern, because experience tells us that the freight-carrying capacity in the United States seems adequate, and often is in surplus, except at those times when grain exports become very active in the marketplace. We, at Cargill, take some measure of comfort in forecasts on other bulk commodities, because salt, chemicals, inorganic fertilizers, ores, and other elements of our business have more stable sources of supply and the demand is more easily measured and understood.

The same can be said, to a lesser degree, of processed agricultural products for domestic consumption. We are a developed nation, and diets have reached as near a perfect balance as medical science can prescribe. Of course, we don't always follow that prescription, but the variations in our diet depend more on individual consumer preference, on universal

economic, social, production, or distribution shortfalls. Thus, we can estimate the amounts of meat, bread, eggs, milk, vegetable oils, etc., the population will consume in a given year, with an acceptable degree of confidence. These estimates can, and are, adjusted by trends in fad foods, in fast food services, and in other variables, so that meaningful projections can be made into the future.

However, U.S. agriculture is not geared to the domestic demand. Our nation is blessed with enormously productive land and suitable climate for food production far beyond our domestic needs. Our national economy depends heavily upon agricultural exports for three principal reasons: first, to minimize the balance of payments deficits; second, to form the economic base for rural America; and third, to provide the economies of scale in production to hold down the cost of food for all U.S. consumers.

These important considerations notwithstanding, U.S. agri-exports are not yet as vital to our economy as they are to other surplus-producing nations; for example, to Argentina, Canada, or Australia. The historical result is that the U.S. surplus has become the residual supplier of world demand. For these reasons, agri-export forecasting requires worldwide production inputs.

On the demand side, world population trends are important elements to consider. Perhaps more important is an analysis of the progress being made by the developing nations toward greater affluence and stronger internal economy. I would like to treat those two separately; first, population growth, and then economic development.

Population has increased at a rate of approximately 1.85 percent per year for the last 25 years. Applying the United Nations' medium varient projection, population will continue to increase an average of 1.81 percent annually until the year 2000. The growth rate is expected to peak at 1.95 percent during 1975-80, the period we are in right now, and then gradually decline to 1.64 percent during the period 1995-2000.

The population in developing countries, including the People's Republic of China, would increase by 2,058,000,000. That figure is 1,749,000,000, excluding mainland China.

On the other hand, populations of developed countries such as ours will increase at a much lower rate, approximately three-fourths of 1 percent per year, or about 229,000,000 by the year 2000.

In this context, it is easily understood that malnutrition is primarily a result of poverty. Most of the world's malnourished live in developing countries: in the Far East and Africa. Between one-fifth and one-third of all people living in the Far East (excluding Communist Asia), the Near East, and Africa have an insufficient food supply. This compares with only 3 percent of the population in developed countries.

Cereals alone could conceivably supply the calories and much of the protein needed by the world's malnourished people. The caloric value of most cereals is similar. About 15/100 kilograms daily of wheat, rice, corn, or sorghum would provide 500 calories. So if the estimated 460,000,000 malnourished people in the world were each provided daily with additional grains equal to 500 calories, much of the world malnutrition would be alleviated.

Table 1 places daily per capita caloric intake in perspective and shows that, as nations develop, more grains are fed to livestock and poultry and caloric intake becomes increasingly in the form of meat. In the United States our daily average per person caloric intake is 3,156, and the amount of calories obtained from cereals is about the same as that from meat. When one looks at the daily caloric intake of 2,121 calories in Southeast Asia, only 77 calories come from meat and 1,589 calories come from cereals.

The world average shows 2,386 calories per day, and 175 calories of meat. The only exception among the developing nations with regard to the ratio of calories consumed as meat is Argentina, and Argentina has a temperate climate and a large beef industry.

The second item that needs to be considered is the economic development in developing nations. Briefly, the historical process and the progress for developing nations is as follows: A country and its leaders decide that it needs to develop because it is too dependent on imports and has an insufficient economic base to provide the needs of its people. It, therefore, designs an economic development plan that usually includes increases in agricultural production and technology, the development of natural resources that are valuable to the developed countries in other parts of the world, and, finally, the training of a skilled labor force to produce manufactured products for both domestic and foreign consumption.

Obviously, the success or the failure of these development plans depends on a wide variety of internal and external circumstances. Furthermore, where success is feasible in the first place, the time element to achieve that goal varies with the particular circumstances each plan must confront. Many developing countries have been struggling mightily for a long time to achieve their objectives.

A composite of these circumstances suggests that forecasting agri-exports is an ever-shifting equation with corresponding shifts for freight-carrying capacity within the United States. I can attest to that during my nearly 33 years of experience.

Most of us in the industry admit that we do not know what will happen next year, let alone the year 2000. The few who think they know are very likely to be wrong.

Nonetheless, if the objectives of this workshop are to be met, we should at least understand in general terms what history has shown us thus far. And, therefore, it seems more appropriate for me to identify the major elements to be considered than to suggest conclusions for the future.

I recently heard Dr. C. Jackson Grayson saying that if one is going to forecast, forecast often and never give a timeframe on any forecast made. I don't know how well I have taken that advice, but so far I am still right.

Generally speaking, the principal influence on agri-exports and their need for U.S. transportation capacity are global climate and arable land; the social and religious customs of peoples around the world; population expansion of various nations; the levels of economic development; and, finally, and perhaps most importantly, various government policies.

TABLE 1 Calories per Person per Day from 11 Food Groups, 1964-66 Average

Country	Region	Cereals	Starchy crops	Sugar	Pulses, nuts & cocoa	Vege-tables	Fruit	Meat	Eggs	Fish	Milk	Fats & oils
Developed												
United States	3,156	649	95	513	103	73	101	598	71	26	397	530
Canada	3,142	670	155	520	73	62	101	622	57	23	378	481
Australia & N. Zealand	3,192	821	101	550	61	47	102	655	52	23	403	377
USSR	3,182	1,544	265	412	60	41	27	240	27	21	252	293
EC-9	3,111	878	179	391	68	59	109	474	50	30	305	568
Eastern Europe	3,080	1,498	183	307	59	49	58	314	31	13	189	379
Japan	2,416	1,397	134	197	146	90	53	53	38	85	62	174
South Africa	2,734	1,583	33	403	55	14	37	254	11	28	147	167
Other Western Europe	2,897	978	191	304	103	69	126	288	38	50	267	483
Average	3,043	1,127	175	388	82	59	76	371	44	32	270	419
Less Developed												
Argentina	2,885	999	180	378	28	30	88	614	24	12	206	326
Mexico & Cent. America	2,425	1,197	107	388	188	14	82	131	16	11	104	187
Other South America	2,276	898	291	363	80	23	62	203	13	21	142	180
West Asia	2,316	1,480	41	187	91	39	113	78	7	4	91	185
China (PRC)	2,045	1,383	224	35	134	33	6	134	12	14	5	65
Brazil	2,541	861	410	401	312	11	48	203	18	13	135	129
East Asia & Pacific	1,969	1,271	245	99	107	27	31	58	7	31	8	85
North Africa	2,290	1,461	104	198	72	43	67	69	5	6	78	187
South Asia	1,975	1,300	29	192	176	35	26	8	1	5	89	114
Southeast Asia	2,121	1,589	70	84	78	29	58	77	8	39	18	71
Africa South of Sahara	2,154	1,109	568	53	180	13	18	61	3	13	32	104
Average	2,097	1,300	191	135	146	30	30	89	8	13	50	105
World	2,386	1,247	186	212	127	39	44	175	19	19	117	201

SOURCE: Food and Agricultural Organization, United Nations, 1964-66 (Table 21).

There are other influences that are subordinate to and associated with one or more of these five elements. My associate, Mr. Aeppli, prepared some graphs that may provide perspectives and suggest areas for additional investigation and research. I will review each of these and comment, where appropriate, on the influence that one or more of the five general elements may have.

Figure 1 shows the history of what has now become an endangered species, and that is the U.S. railroad boxcar. This figure shows that the number of railroad-owned boxcars will be down to zero some time in the late 1990's; that plain boxcars of the total fleet will be virtually gone, but some will still be around because of private shipper fleets. The equipped boxcar fleet will increase, although on a rather flat scale to something a little over 200,000 by the year 2000.

The decline in the fleet of boxcars really began with the advent of modern highways and increasing competition from efficient trucking service. This decline has accelerated in modern times with piggyback and container technology and with the development of the 100-ton covered hopper car. After the hopper car transition was complete, we literally redesigned elevators that could not unload boxcars. We just did not want them around because of the differences in efficiency between boxcars and the covered hopper car.

Figure 2 shows the hopper car story and, if anything, it shows that linear projections may be dangerous. Very little confidence should be placed in these projections, but the first shows through the use of historical data what happened between 1968 and 1977. The second, the tiger-leasing projection, was made to try to provide forecasts and to aid them in developing their own leasing business. The third is a linear projection that used the data that was available between 1975 and 1977 and what was happening during that very short period of time with freight car construction.

Currently, I am told that in the last half of 1978 freight car construction is booming and it is expected to continue through 1979. So it very well may place the actual construction, as of January 1, 1980, something above the most optimistic of the projections shown in this figure.

Principal influences that might be brought to bear on hopper cars are the government policies on both energy and "lock and dam 26",[1] although I think the latter is a minor issue. There may be others. Interstate Commerce Commission policy and car service regulations can have an influence. Another we heard about earlier was the availability of capital.

Let's now look at Figures 3 through 13 that give export-import figures for various regions around the world. That is where much of the forecasting needs to concentrate to project freight-carrying capacity requirements in the agri-business for the next 20 to 25 years. The United States consumption (Figure 3) has been on the increase, except for 1974, when there was a substantial dip due to a recession coupled with high prices. At that time, stocks were being depleted because of very heavy export movements. That demand reduced our stockpile of reserves to the point where people were worried about having enough to

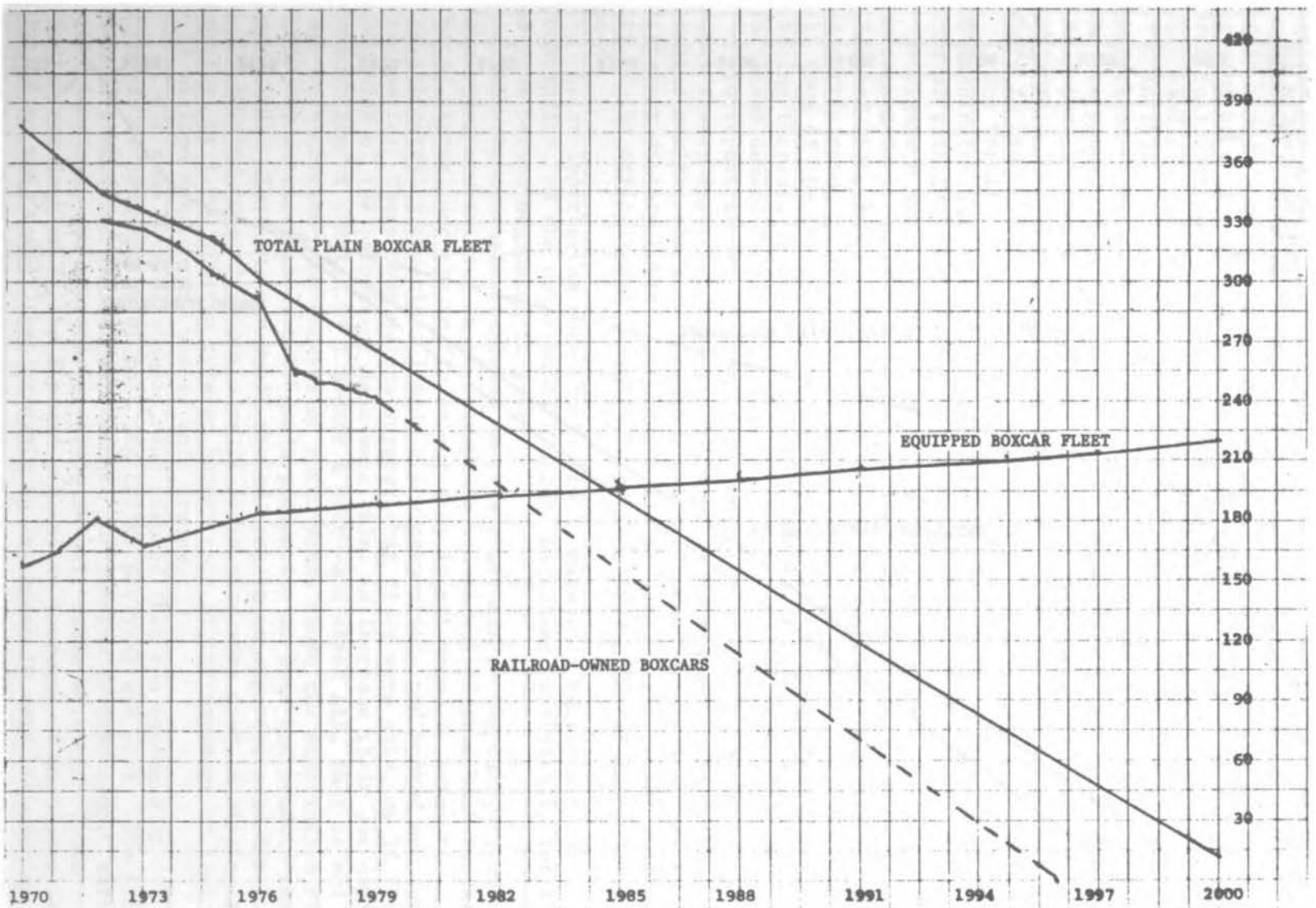


FIGURE 1 Railroad-owned boxcars. SOURCE: Cargill, Inc., 1978.

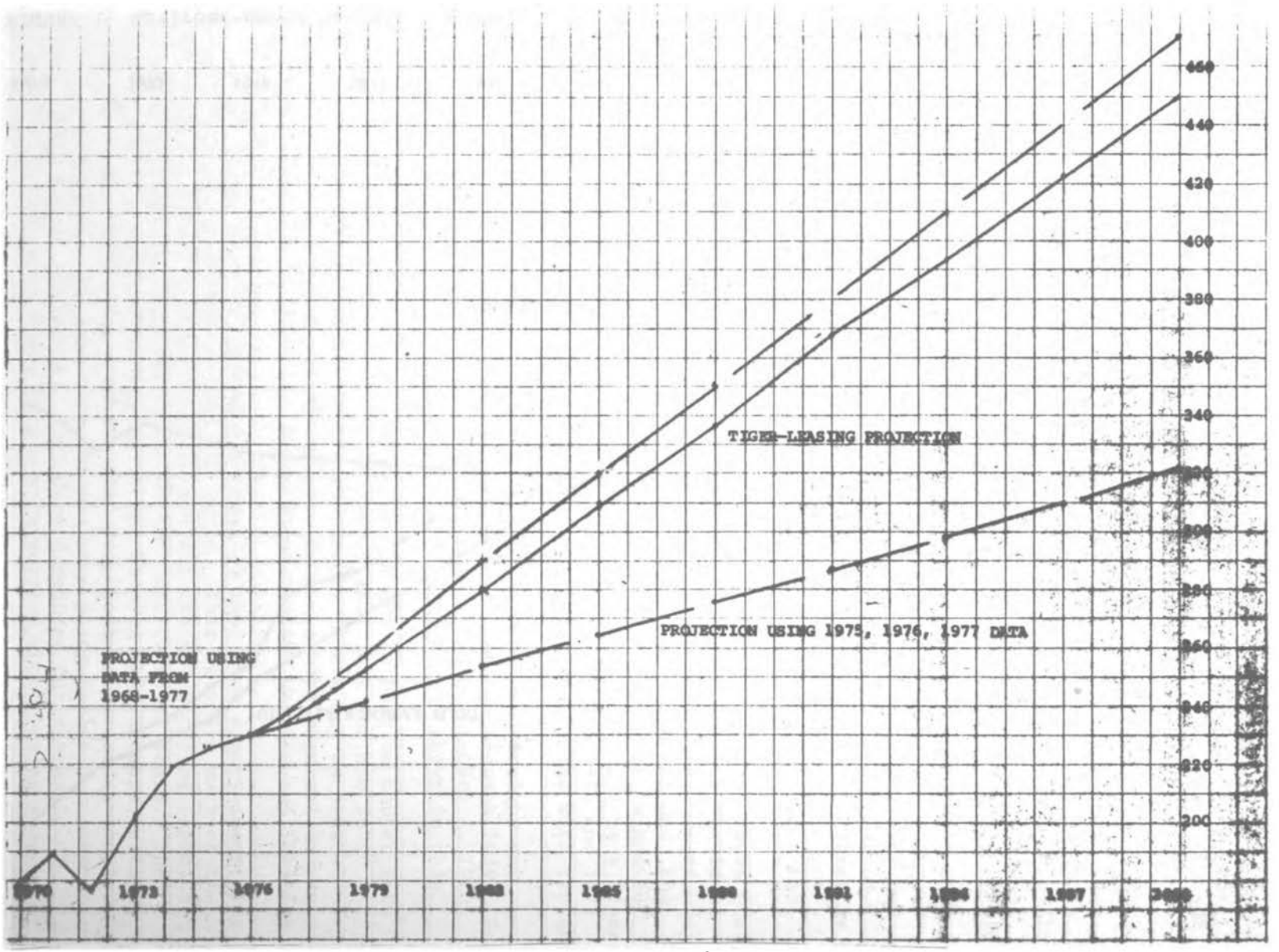


FIGURE 2 Hopper Cars. SOURCE: Cargill, Inc., 1978.

satisfy our domestic needs through to the next crop. The President imposed an embargo on soybeans that alienated us as a nation and as a grain trader with several countries of the world. These countries were relying on contracts already made for soybeans, but we were prevented from fulfilling our commitments because of the embargo. We hope that that kind of circumstance does not arise again.

In 1974, the Department of Agriculture adopted a policy that encouraged farmers to pull out all the stops and produce all they could. They responded magnificently. Figure 3 shows that in subsequent years the export volume continued to go up, and still our stocks and our carryovers for domestic use continued to rebuild to some semblance of where it had been.

The farmers did such a good job of production that they had to come to Washington and march on Capitol Hill this past winter to get some kind of stimulation in prices.

Figure 4 shows that Africa has held its own fairly well, with increases in production to offset the increases in consumption. But in 1972 and 1976, it required record imports to sustain consumption growth. We participated in some of that export with U.S. production. I believe all five of the influences I alluded to before had a bearing on the continuing increase in consumption and our ability to help satisfy the increased demand in Africa.

To repeat those: The political unrest in Africa as a continent is still a very important factor; the economic development versus the controlled wealth; the social customs and whether or not they adjust to different dietary habits; population trends; and, finally, the suitability of the agricultural climates to expand production for their own needs.

Asian imports, as shown in Figure 5, have been relatively flat. Consumption, on the other hand, has gone up rather consistently for the 15-year period beginning in 1961.

All the countries included on this chart are in the category of developing countries. In an attempt to equate all of this back to the United States, and try to figure out what it all means in terms of freight-carrying capacity, I made a few assumptions and worked out some arithmetic. These conclusions suggest that if we were able, or if the economies of the peoples of Asia were able, to increase their per capita consumption of chicken by 5 pounds a year--and after all, that is not very much chicken--the conversion ratio would cause the exportation of 4,950,000 metric tons of U.S. grain production to feed and produce that many birds. That in turn would equate back to an expanded need for 3,100 100-ton covered hopper cars if those cars were used in single-car service, or 1,000 100-ton covered hopper cars if the movement of that 4.95 million metric tons was in unit trains.

I did some more arithmetic, and assumed that the increase of 5 pounds of consumption of meat per capita per year was pork. The final numbers identified an increased demand for 100-ton covered hopper cars, 4,400 in single-car service, or 1,460 in unit train service. Those figures are doubled if the 5 pound per capita increase of meat were beef. Therefore, when and if the forecasts on increases in meat consumption

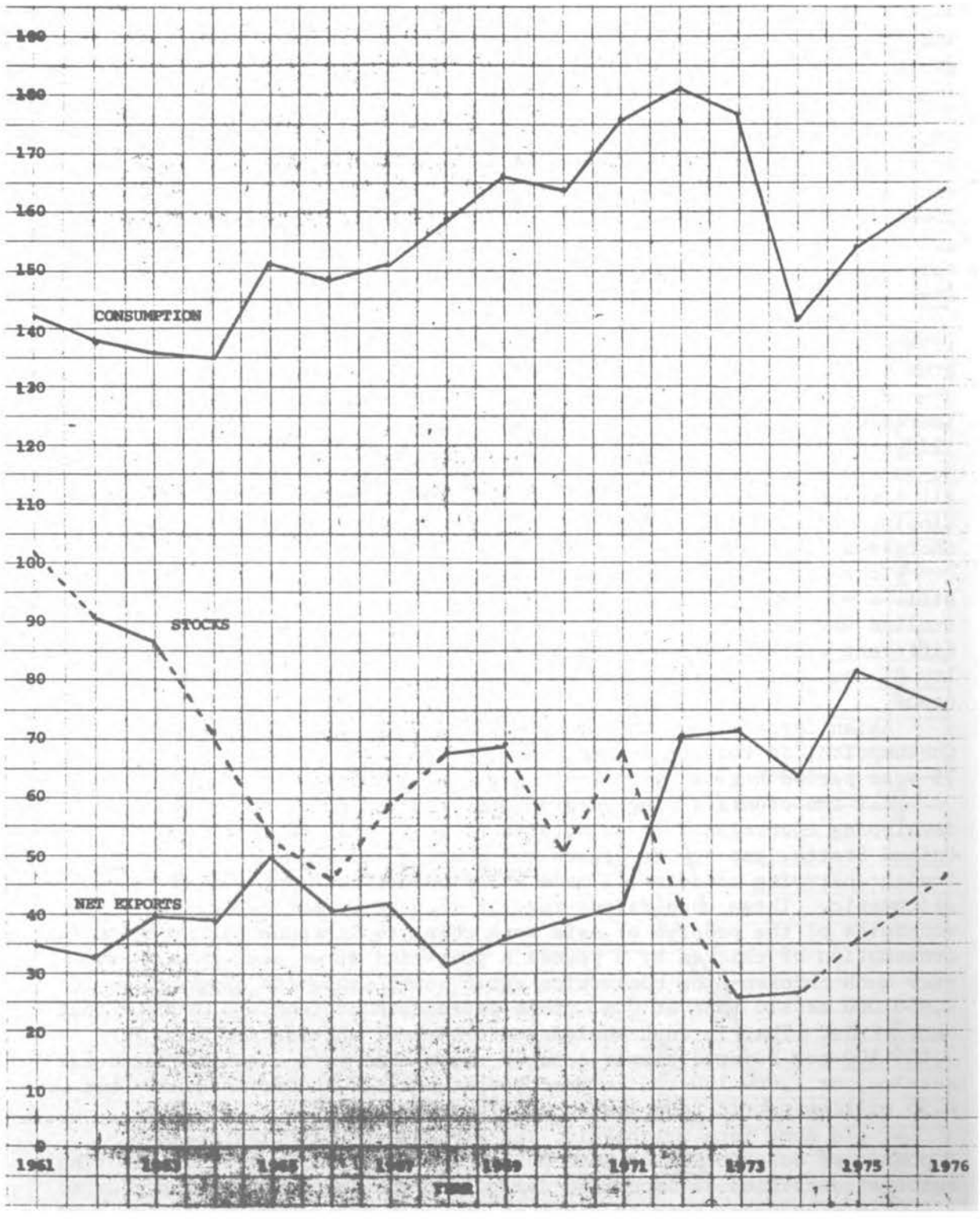


FIGURE 3 U.S. exports, consumption, stocks. 1,000,000 metric tons.
SOURCE: Cargill, Inc., 1978.

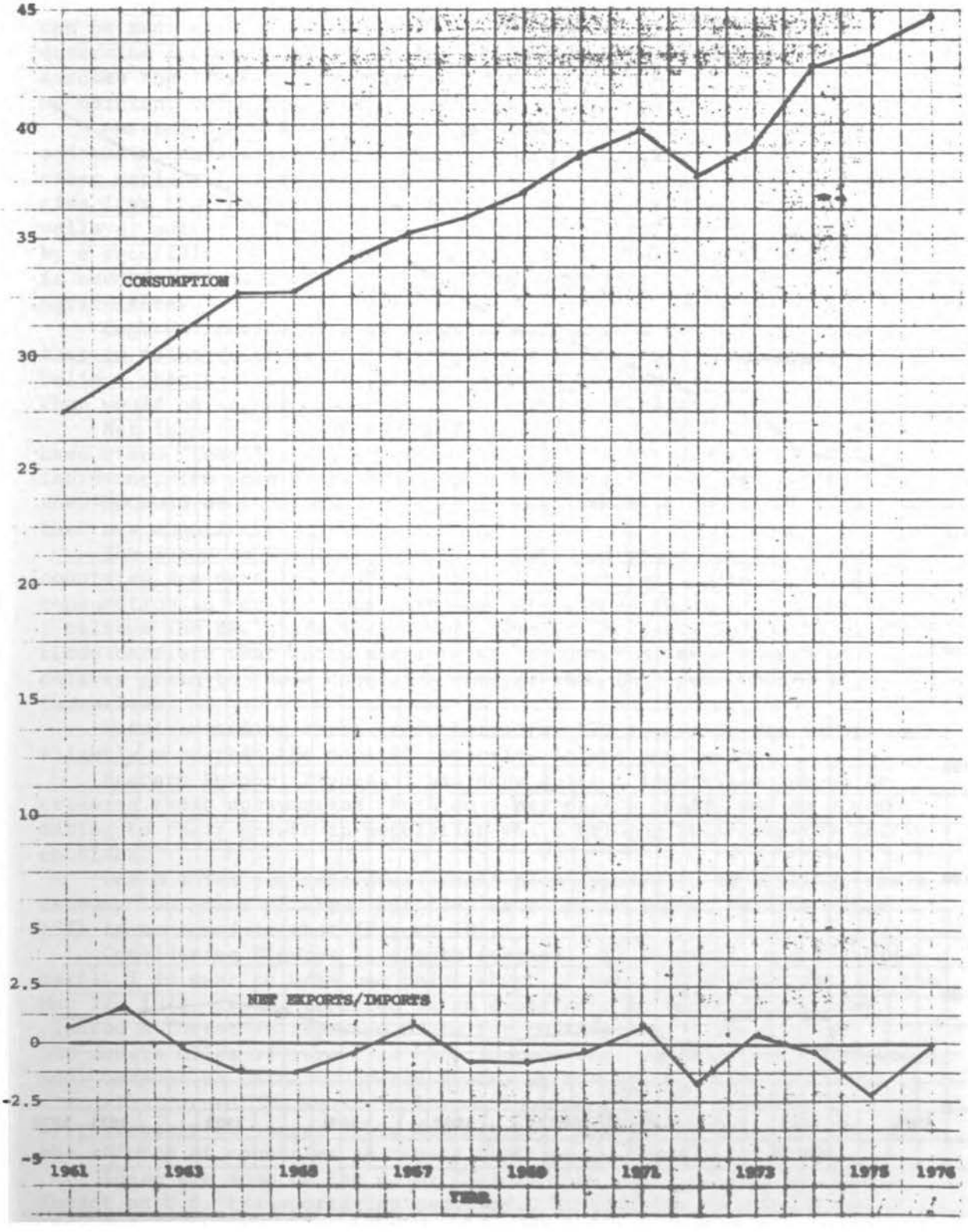


FIGURE 4 Africa--total grains, consumption, imports/exports.
SOURCE: Cargill, Inc., 1978.

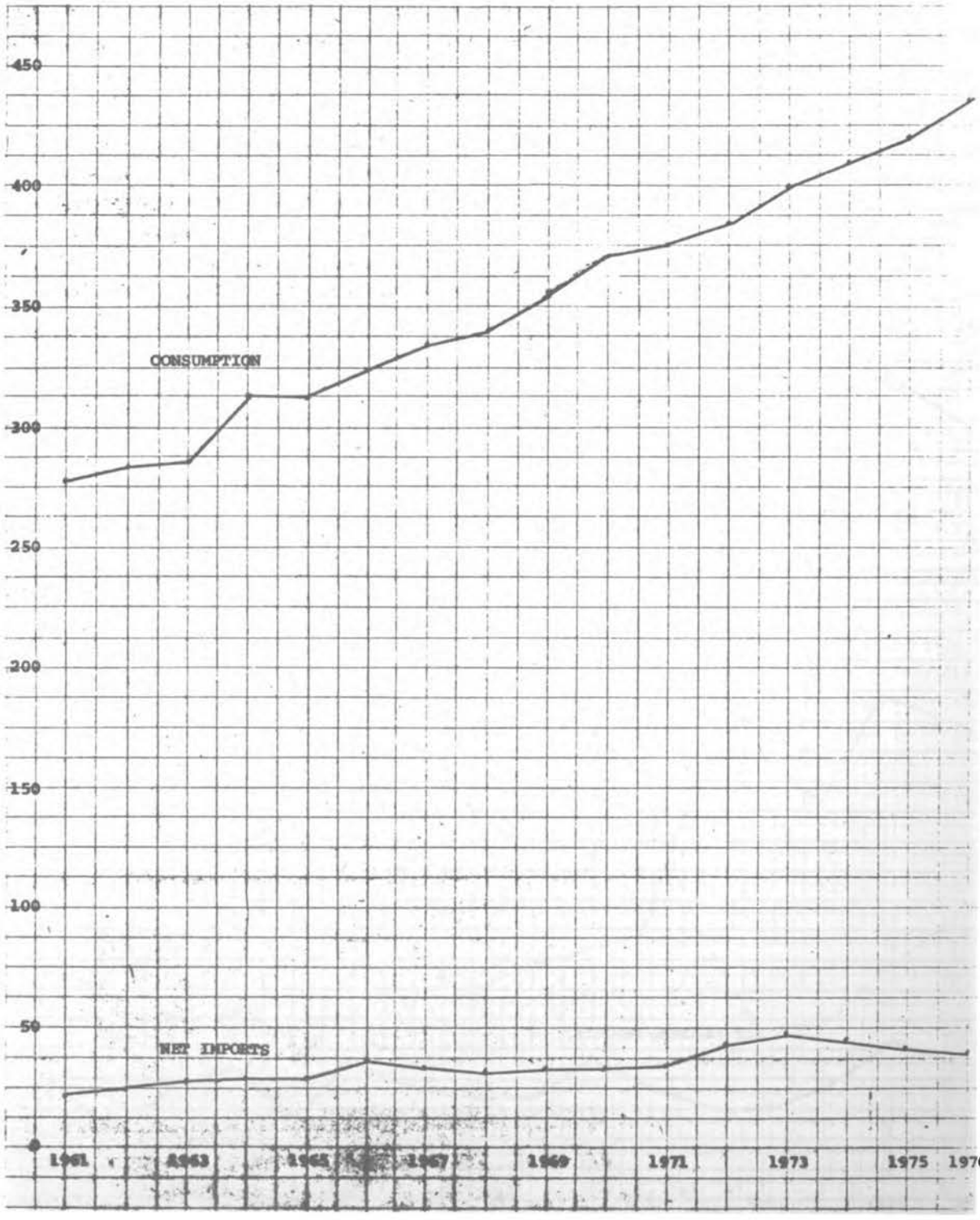


FIGURE 5 Asia--including People's Republic of China, imports, consumption. SOURCE: Cargill, Inc., 1978.

can be made with reasonable reliability, those forecasts can be used to determine increases in demand for freight-carrying capacity. This assumes the river system stays as it is today. Today it is handling, in my opinion, volumes approaching maximum economical and feasible capacity.

Australia and New Zealand, the Oceania area, are shown on Figure 6, and their comparative metric tons are quite low when contrasted with other nations, but we can readily see the influence of government policies from that chart, because exports appear spotty, with peaks and valleys, suggesting that heavy exports for economic reasons are followed by a rebuilding of reserves. That is just my own opinion, and I think it needs confirmation from some of the economists at the Department of Agriculture.

Central America (Figure 7) appears to have a developing economy that is doing quite well in terms of the increases in consumption. I believe that the increase in consumption does climb in the chart faster than would be suggested simply by a growth in population.

Net imports are also a significant factor, because since 1968 they have risen steadily. It suggests that Central America's economy is improving; its people are becoming more affluent; they are eating better; and, because of that, they are required to import more grains to satisfy that new appetite.

The European Economic Community (EEC) and other Western European countries are detailed in Figure 8. It is interesting to note that consumption in non-EEC countries has outstripped those within the EEC. I believe the EEC's statistics show some of the heavy influence of the trade barriers that encourage internal production, even though we can deliver grain to those countries cheaper than they can produce it themselves.

Notwithstanding these trade barriers, EEC countries are importing slightly more than the non-EEC countries in Western Europe.

Eastern Europe (Figure 9) has done quite a remarkable job of increasing their consumption, both on a per capita basis, and on accommodating to their growth in population while holding their imports fairly constant.

The Russian economic development plan appears to be working from a consumption point of view, but they have had to import heavily since 1971 to accommodate that (Figure 10).

Considering Figures 11 (South America), 12 (Canada), and 13 (Mideast), I do want to make one point about climate. *Time* magazine, in the May 22, 1972, issue, reported on an experiment in Brazil where they cleared a forest in Esperido Santo for cultivation. They cleared 300 square miles of forest to help improve their agricultural production, and, because of climate, it has become an ecological disaster. They virtually turned 300 square miles of lush jungle into a desert in approximately 20 years. This demonstrates the influence of climate on the efforts of countries to expand their agricultural production.

These are some of the major factors that will continue to have an impact on U.S. transportation capacity. In addition to significant global influence, that capacity will be equally affected by scores of U.S. government policies. I have already mentioned some, but others

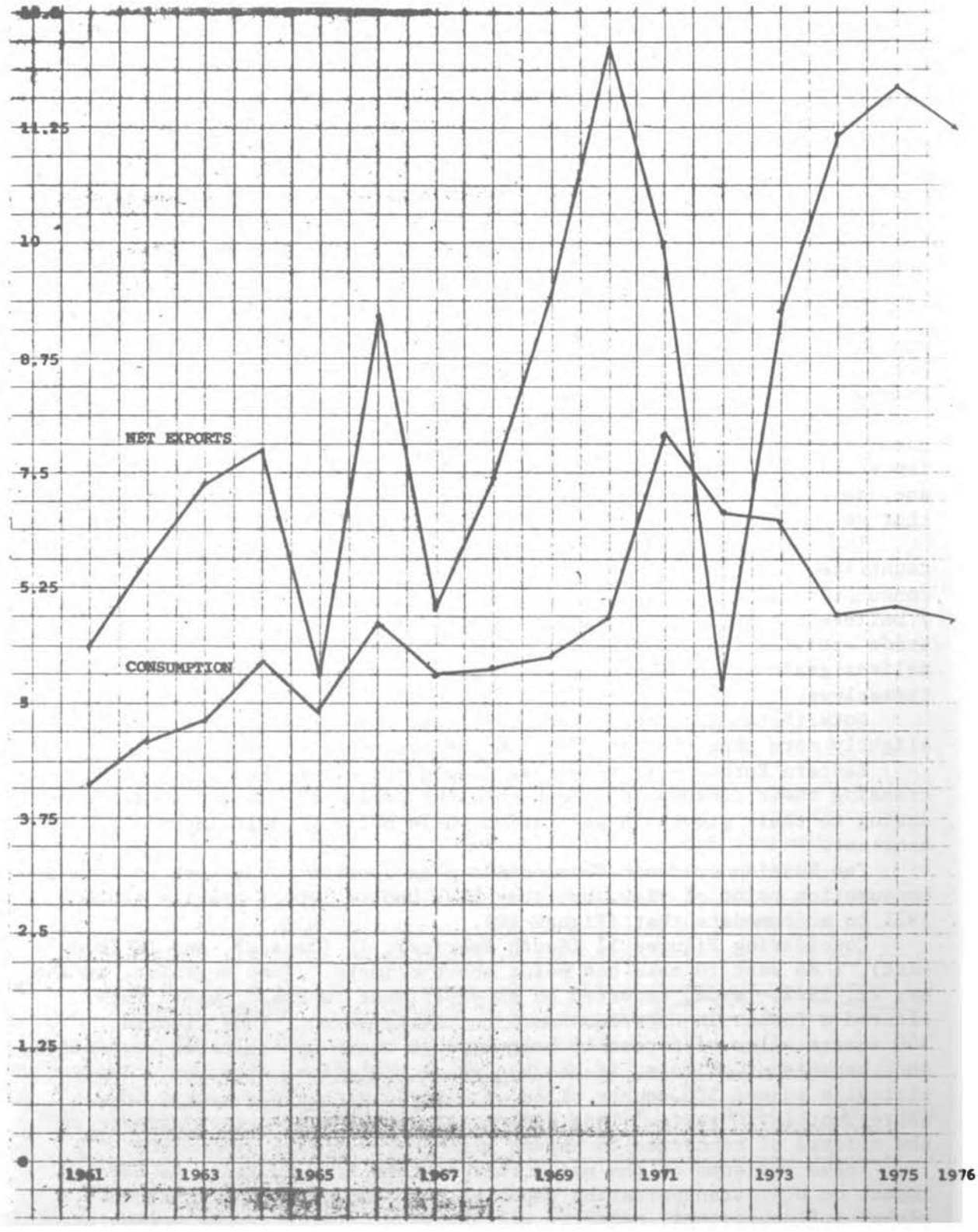


FIGURE 6 Oceania--exports, consumption. 1,000,000 metric tons.
SOURCE: Cargill, Inc., 1978.

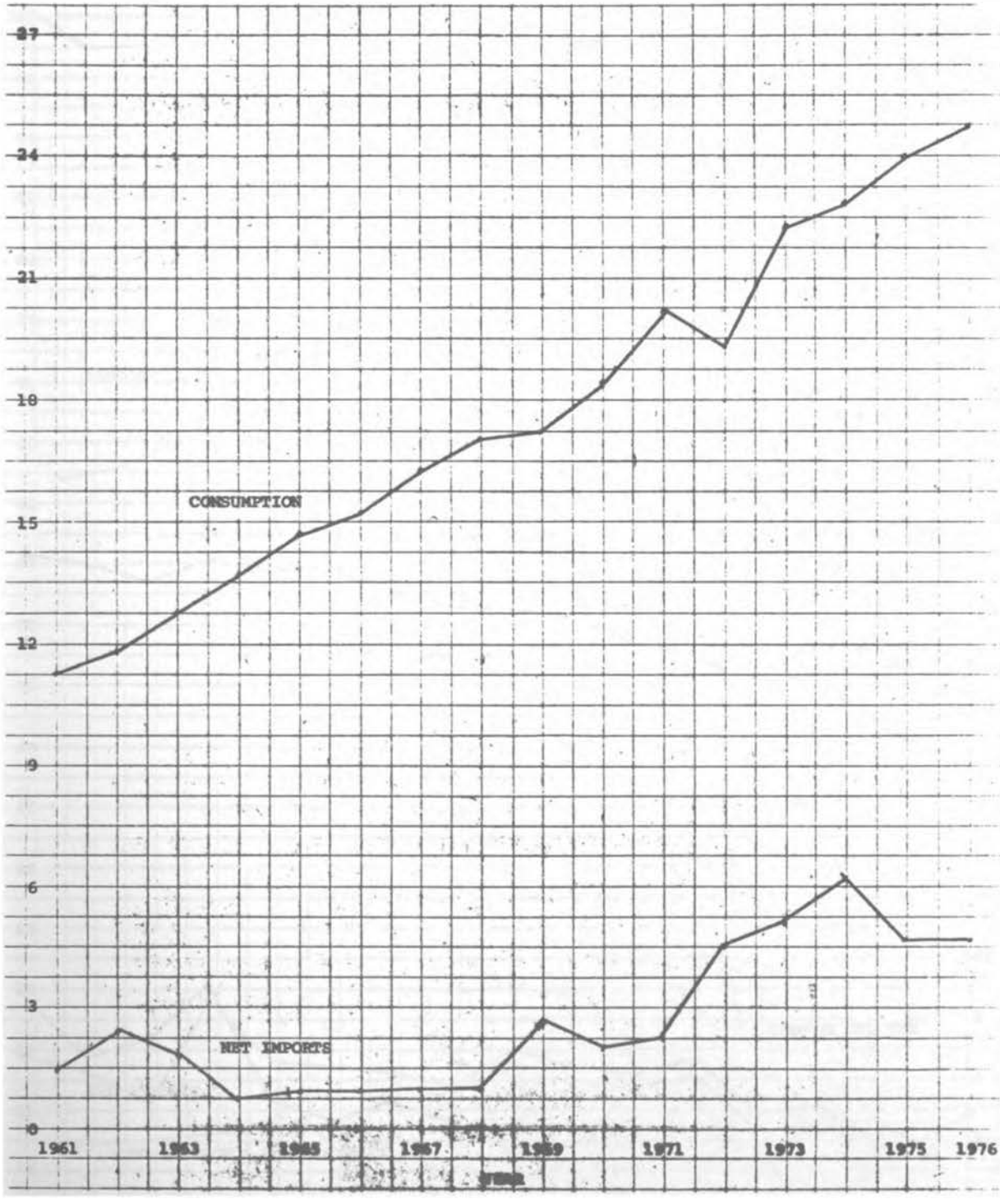


FIGURE 7 Central America--consumption, imports. 1,000,000 metric tons.
SOURCE: Cargill, Inc., 1978.

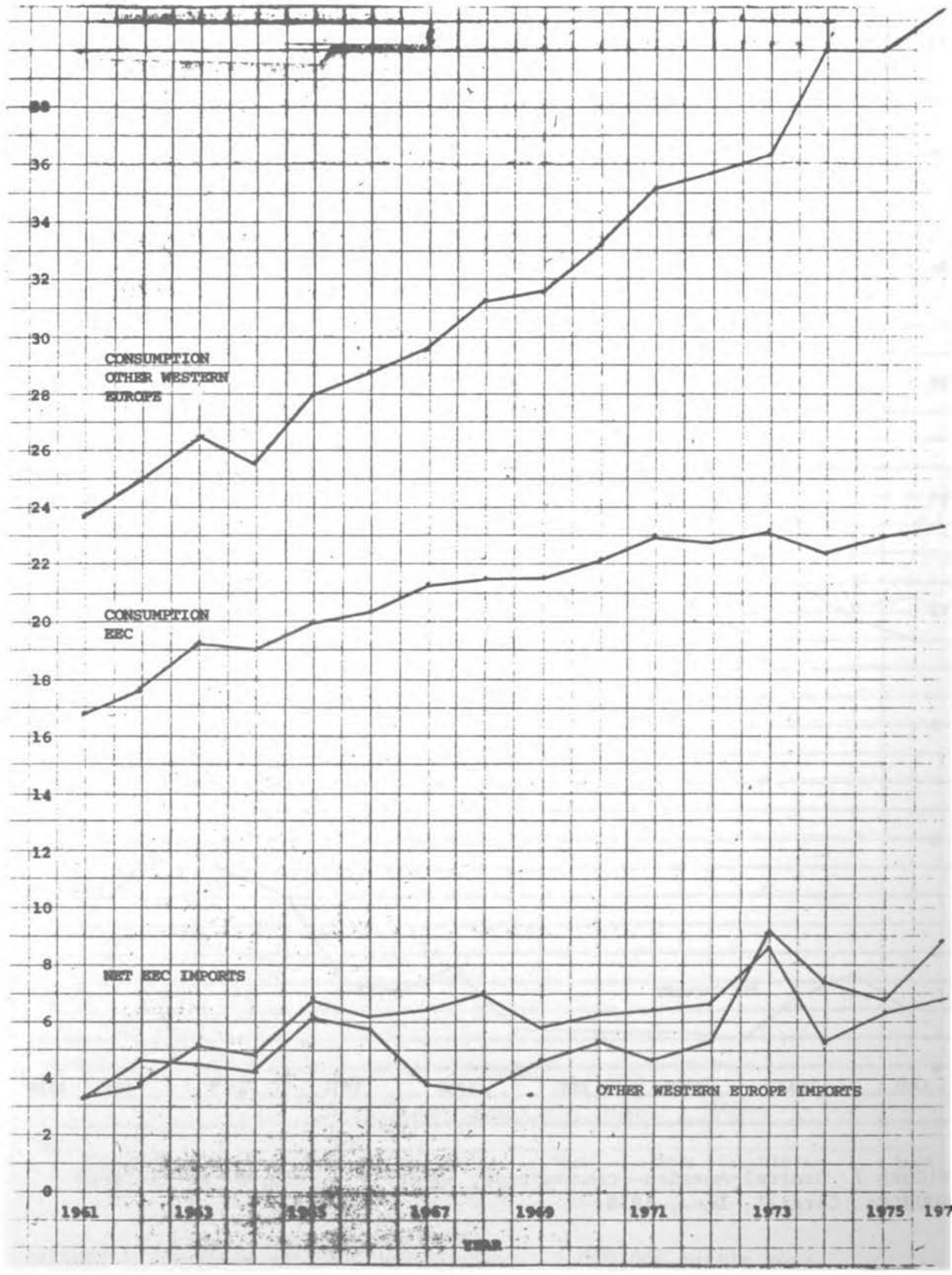


FIGURE 8 EEC Europe, other Western Europe--consumption, imports. 1,000,000 metric tons. SOURCE: Cargill, Inc., 1978.

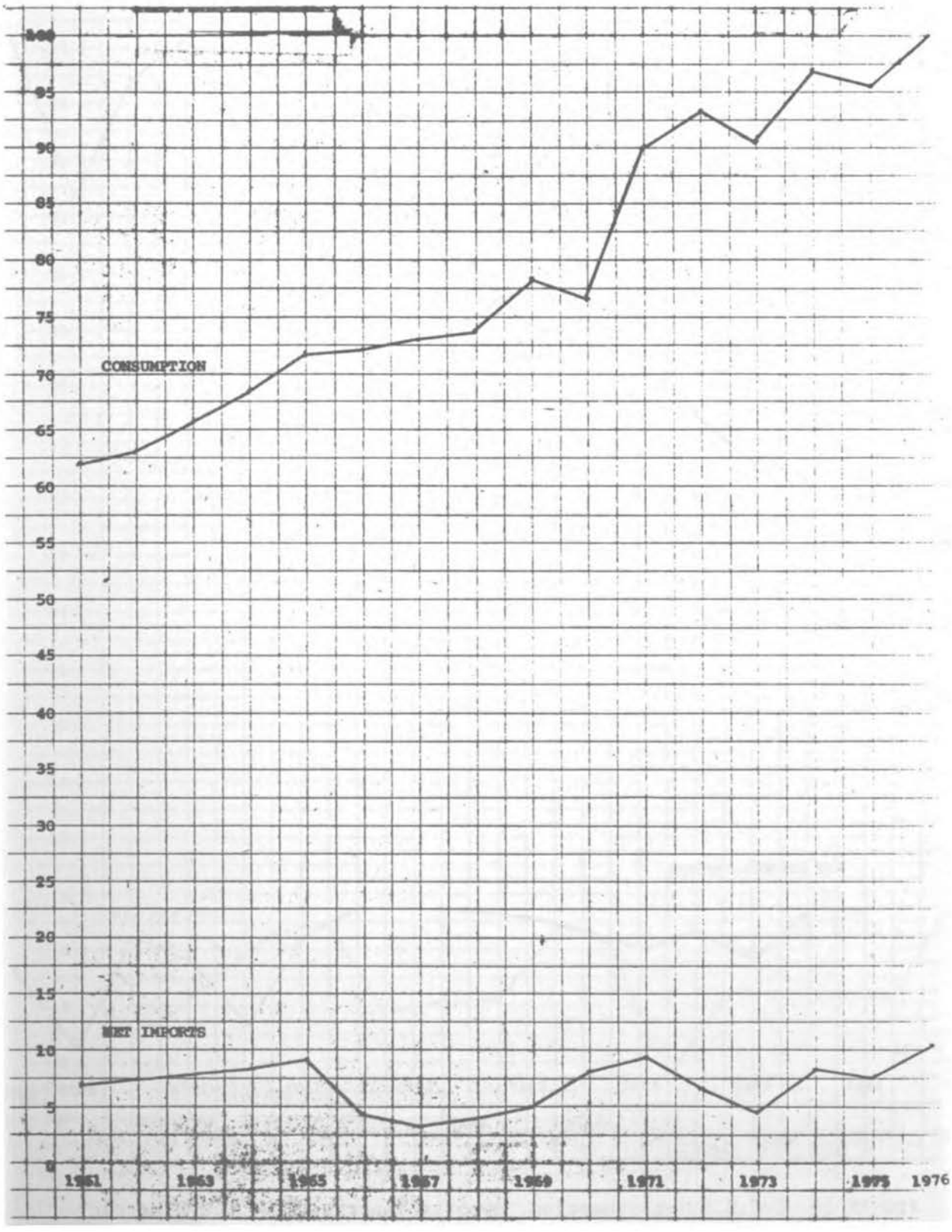


FIGURE 9 Eastern Europe--consumption, imports. 1,000,000 metric tons.
SOURCE: Cargill, Inc., 1978.

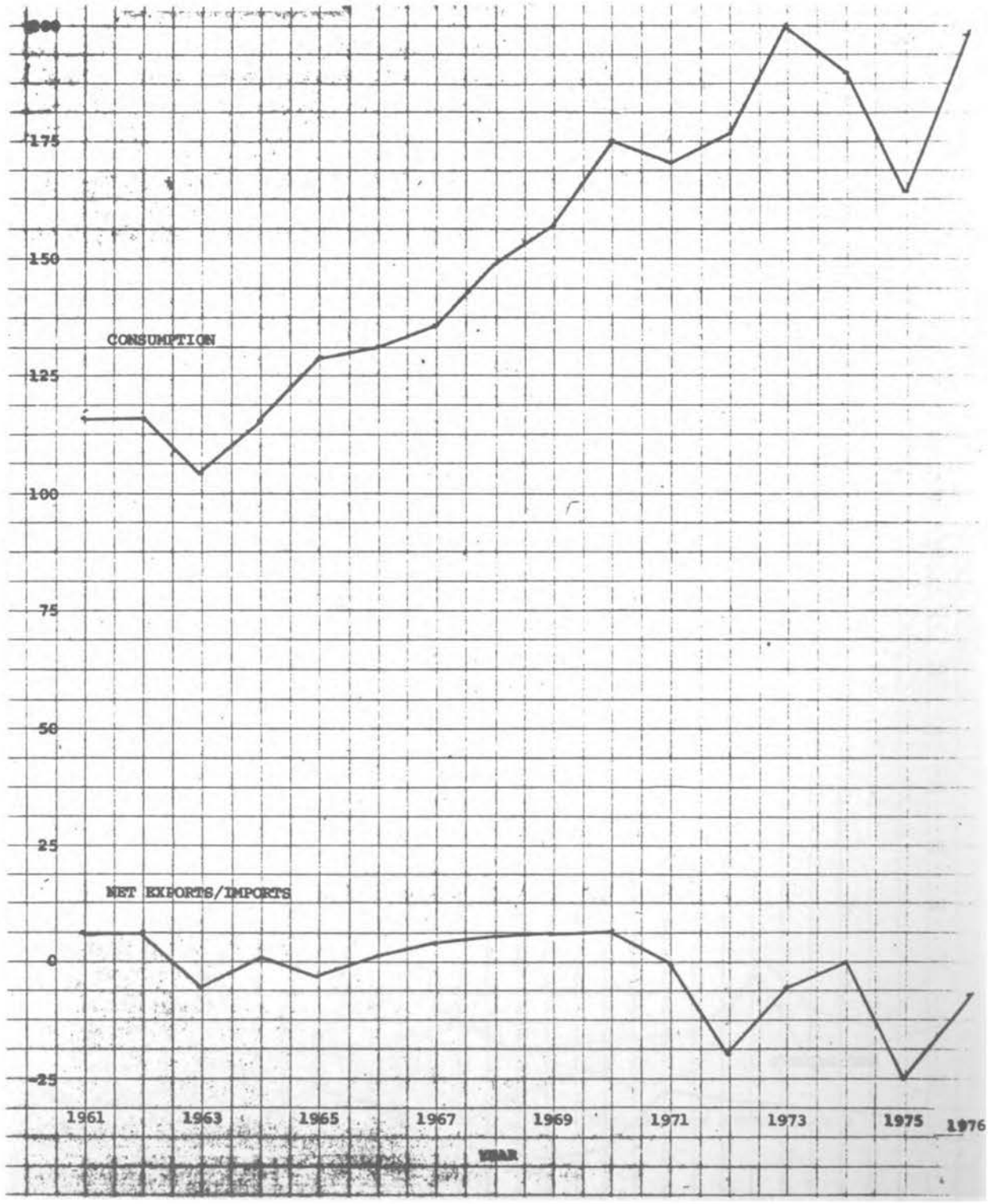


FIGURE 10 U.S.S.R.--consumption, exports/imports. 1,000,000 metric tons. SOURCE: Cargill, Inc., 1978.

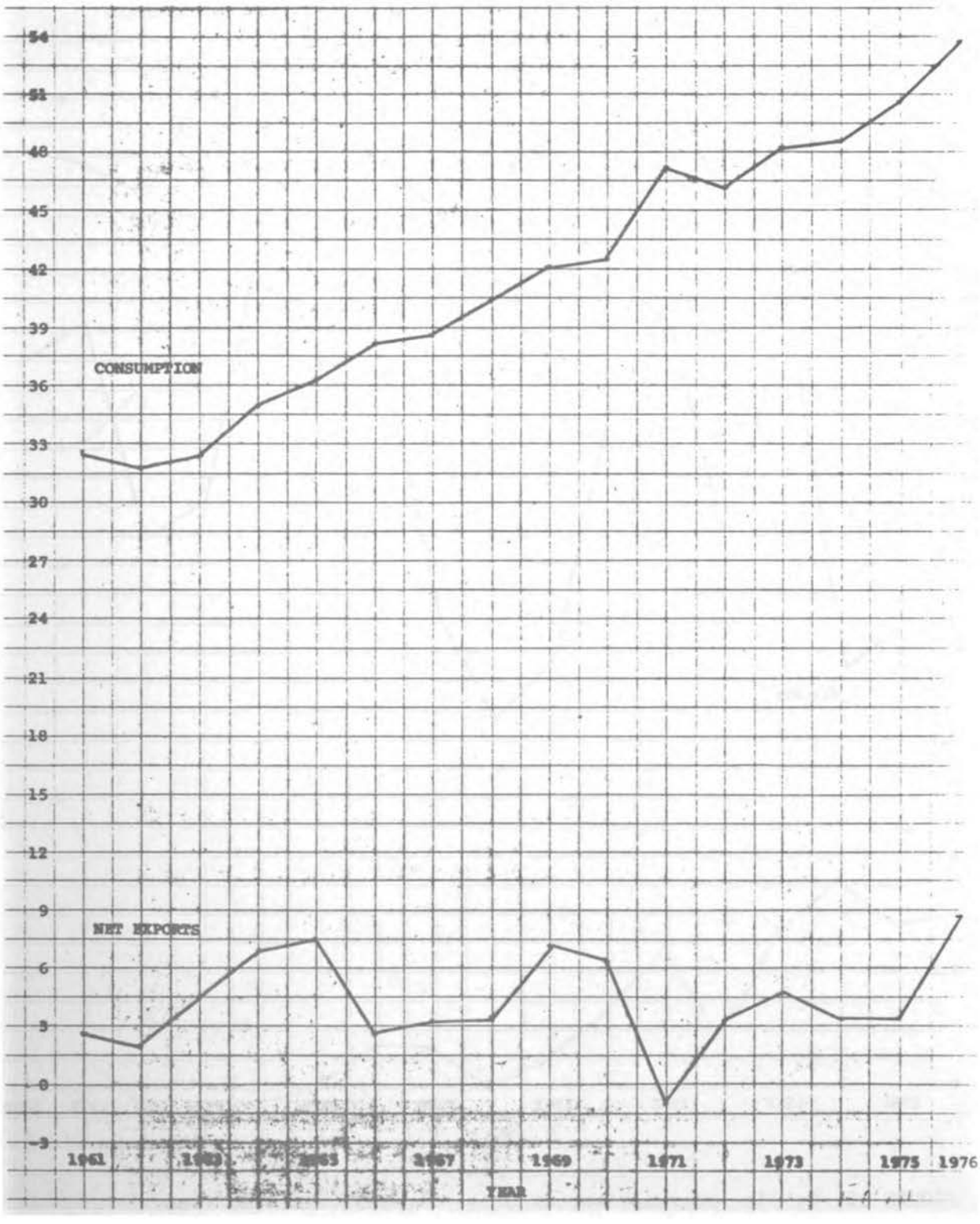


FIGURE 11 South America--consumption, exports. 1,000,000 metric tons.
SOURCE: Cargill, Inc., 1978.

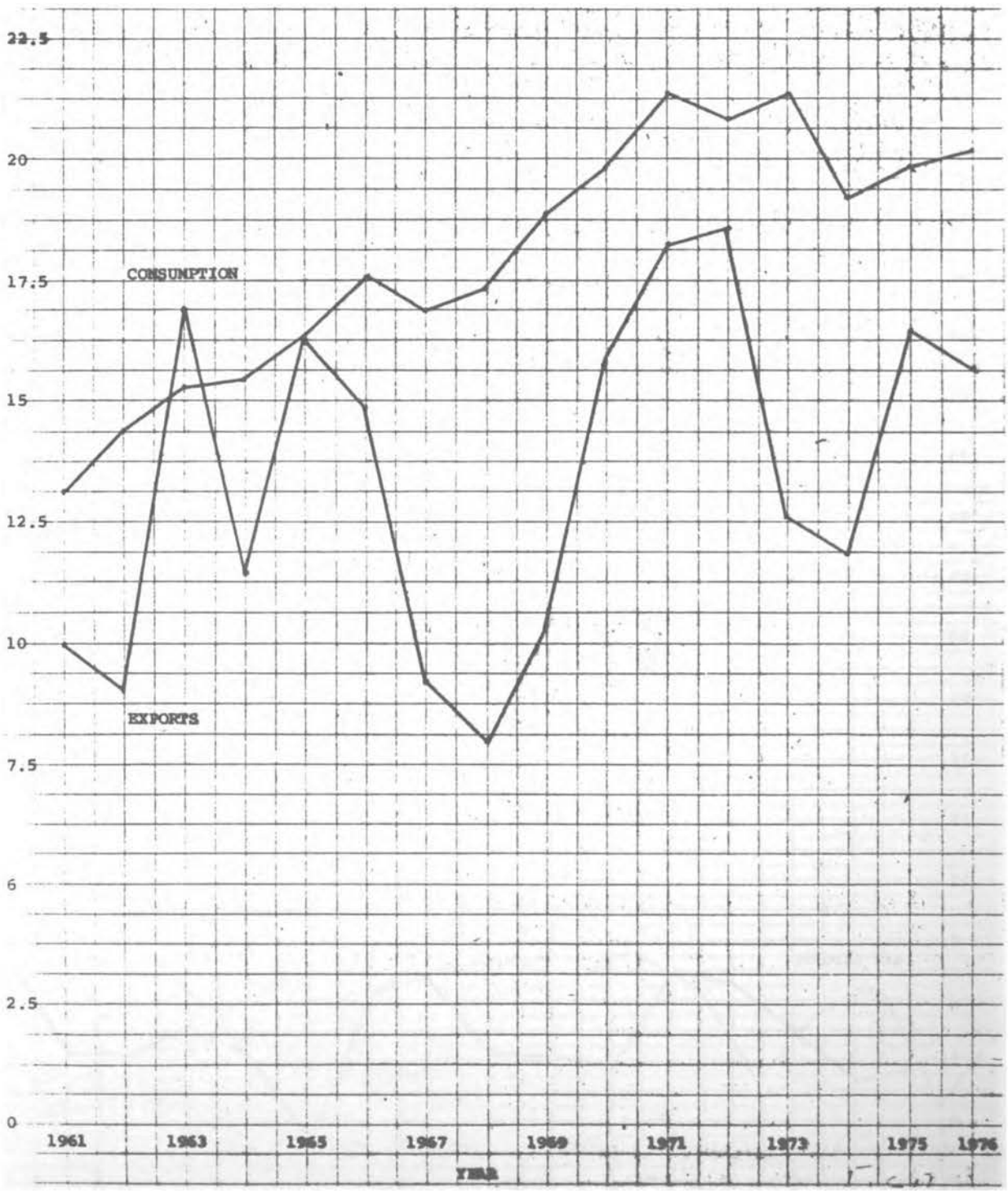


FIGURE 12 Canada--consumption, exports. 1,000,000 metric tons.
SOURCE: Cargill, Inc., 1978.

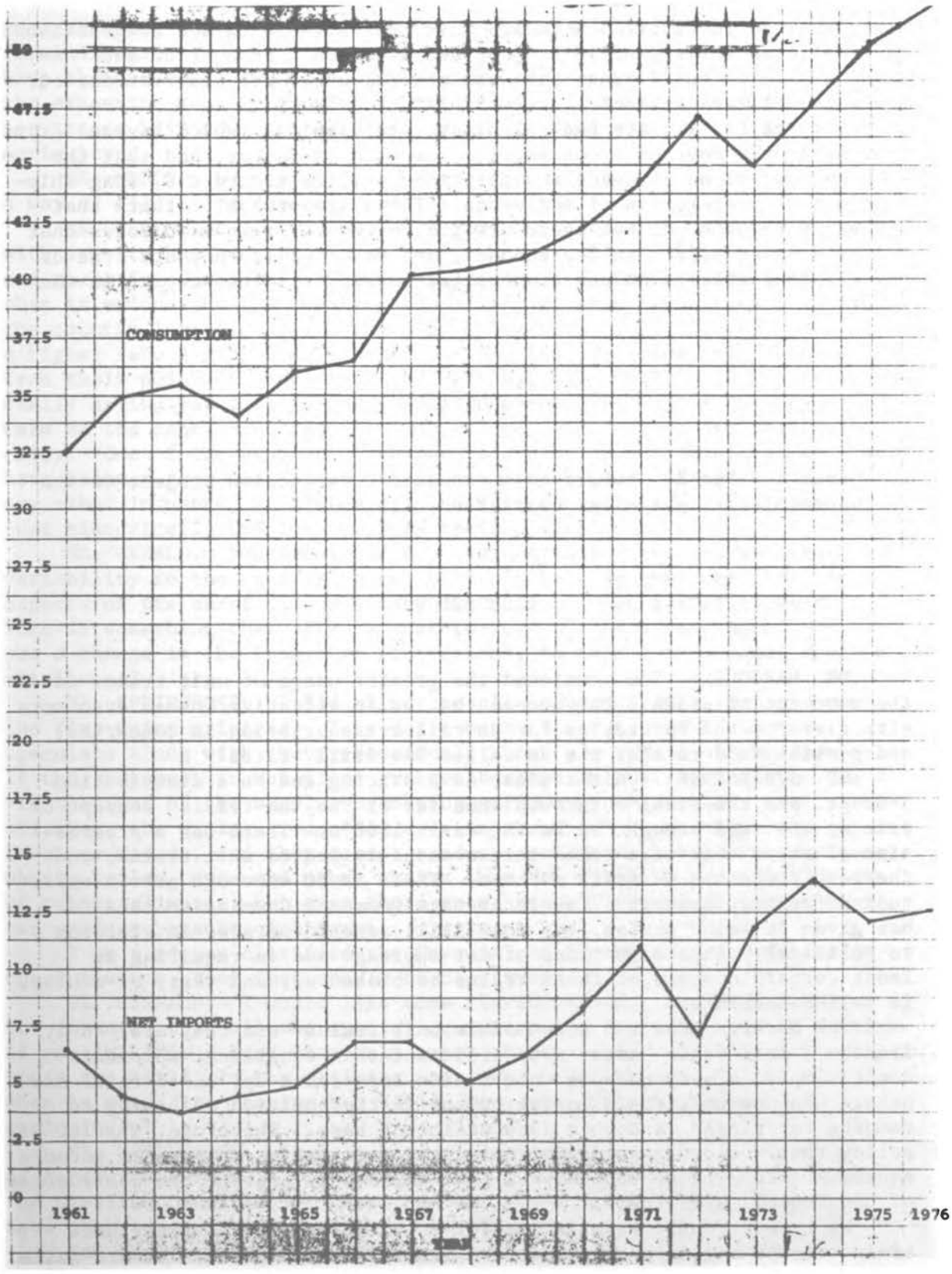


FIGURE 13 Mideast--consumption, imports. 1,000,000 metric tons.
SOURCE: Cargill, Inc., 1978.

might include ICC attitudes toward unit trains and USDA and congressional farm policies. For example: Do we encourage full production and exports? Do we build capacities and provide strategic reserves for our own national consumption?

I think DOT and its federal highway regulations, which have a bearing on the cost of truck service, are also a factor, and that the embargos we had on soybeans and maritime policies toward U.S. flag shipping are all categories of influence. There are probably others that I haven't thought of, but there are really few government policies that do not have an effect on the economy, and fewer still that are free of the rippling effects on our transportation capabilities now and in the future.

NOTES

1. "Lock and Dam 26" refers to a proposed construction project on the upper Mississippi River near Alton, Illinois.

DISCUSSION

DR. MARGOLIN: You mentioned the greater usage of unit trains for the movement of grain. Do you see that as an effective force, even more effective for the future, as far as rail transportation is concerned; and possibly add to that the so-called "no frill" rates?

MR. SPRINGROSE: Unit trains, as a pricing and as a distribution concept, are the final outgrowth thus far of the "no-frills" concept of pricing that was brought on in the early 1960's. There was a progression of steps that were taken that eventually led to unit trains, and the result was the no-frill concept. There is an enormous growth opportunity for that concept. The Interstate Commerce Commission thus far has given it faint praise, but they still seem to persist in yielding to political pressure in times of car shortage and in requiring at least certain numbers of those trains be broken up, and that, of course, is self-defeating.

The markets that can accommodate unit trains--and they are, on at least a 3 to 1 ratio basis, more efficient than single-car shipments--don't simply go away because unit trains are broken up, and Cargill and others who use unit train logistics are in the position of having to compete for single cars on a less efficient base. Therefore, the ICC policy that would set aside and designate unit trains as special purpose equipment would be a step forward that would help prevent the destruction of the economies of scale.

We have recently been successful in establishing the first unit train rate on milled wheat flour for domestic consumption. We are quite

excited about that. We will have to spend some $2 million to build a terminal that can handle the unit train efficiently, but at least we have the economic base to go forward with the construction. I do see the expansion and the growth of unit trains and point-to-point, no-frill service as having a good deal of flexibility and opportunity in agriculture.

DR. MOSES: Do you see much scope for differential peak pricing as a way of allocating freight capacity over time?

MR. SPRINGROSE: To date, we really haven't had a lot of experience with it. It has been tried, however. We have lived through one harvest, and there is a proposal in the south to try it again. I don't know that it encouraged the construction of any storage facilities back at the country level in anticipation of a lower rate, or in order to avoid a higher rate during the peak period, but the railroads tell me that from their point of view it worked very satisfactorily. What they are really saying was that during the fall quarter they had more money to take to the bank, handling the same volume, and I don't say that critically. One of the problems with the railroads is a lack of capital; we have heard a good deal about that this morning, and, if agriculture or any other industry can afford it, I don't think it is our business to just historically try to beat down their prices.

MR. GERALD: You mentioned in your Australian-New Zealand chart the variability in the exports there. I don't believe that the sinister aspects of the chart are caused by man actions, but rather by weather. That is something that affects year-to-year movement very much. Do you see a change in the long-term projections, to take into account weather attributes?

MR. SPRINGROSE: I did allude to climate and arable land as one of the five major criteria. I am not a meteorologist, and I can only speculate along with the professionals about the return of the Ice Age. If that happens, it may place greater burdens on U.S. Agriculture vis à vis the rest of the surplus-producing nations of the world. If I am not mistaken, the entire production area in the U.S.S.R. is about the same level as Canada, and they cannot produce corn or soybeans; they produce wheat, barley, rye, and other grains that are suitable for those types of colder climates, but even there they have a limitation on what they can produce because of climate.

I am glad you clarified the Oceania chart, because, if weather is the influence, then that should be clarified.

DR. HERWALD: I would like some clarification. How do you afford the investment in all the special equipment and the intensity of storage if you look for a good crop only every third or every fifth year? Who foots the bill? Is the ultimate user, who buys the product downstream when he needs it, footing the bill? Or is the U.S. Department of Agriculture?

MR. SPRINGROSE: It is a mix. I don't think it is the Department of Agriculture that is footing the bill. It has been many years since the Civilian Conservation Corps had any stocks in storage. That may have changed, too, very recently, but I am not aware of it.

You are talking about the capital it takes to gear up to the logistics programs.

DR. HERWALD: Like the unit train.

MR. SPRINGROSE: Yes. Actually the unit train and the capital requirements that brought about its construction showed it was cheaper to do it that way. The return on investment was such that we just had plain, straight-out, free enterprise economic justification for doing it, and that is one of the major reasons we did it.

To some extent, we were forced to do it because the economic viability of the inland waterway system had about reached the saturation point, not totally, but it was getting close, and ocean vessels were five times the size and called for five times the tonnage that they carried away from our shores just after World War II. We also had a logistics problem trying to fill the voids with single cars of grain. The unit train, as a concept, made it more efficient. The railroads that provided the initial thrust to developing the concept gave us ample reductions in the rates because of the economies of scale. They cut the rates by more than 50 percent, and they made more money hauling the goods than they did on the old basis. Therefore, there were some valid economic reasons to use unit trains, and, because the cost of distribution was so much lower, we were able to make a free enterprise capital investment. Somewhere between the foreign consumer and the U.S. producer, all costs are absorbed. But the producers, in this particular case in Illinois, are very independent people, and the only reason they sold grain to Cargill for placement on its unit train was because we paid them more money for it than they could get anywhere else. So, from the standpoint of the competitive impact on the goods they produced, we think we were good for the economy back in that particular producing area. We brought a new market force to play, and they wouldn't have sold it to us if we hadn't been paying the best price.

DR. BENTZ: What modal bottlenecks, if any, both nationally and internationally, do you see in meeting future exports of grain?

MR. SPRINGROSE: In the inland waterway system, "lock and dam 26" needs to be replaced. I don't quarrel over what the user fee should be. I think it should be a reasonable fee, and I think Congress ought to quit fencing and get something going, because that is a 10-year project, as you know, and it is already becoming a serious economic problem throughout the agricultural distribution system.

Bottlenecks currently are: (1) three major elevators whose capacities are not now available to agricultural exports because of explosions. (2) The St. Lawrence Seaway has not really become as viable an artery for export commerce as it was heralded or as it was supposed to have been. I don't suggest we tamper with it. I don't know that anything can or should be done with it, but in terms of looking to the Seaway as the fourth seaport from the standpoint of agricultural exports, it is not as important a factor as was originally forecast, albeit still important for production out of the upper Midwest through the port of Duluth, and to some extent through Chicago, Maumee, and Toledo, Ohio, but not nearly as extensive as it was projected. (3) The lack of unit train capability for vast production--say, west of the Missouri River. We don't have the density of yield per acre in wheat that we have in corn and soybeans, and so you really have to reach too far out to bring it in to a unit train loading station by truck.

The relatively high costs of trucking offset the economies of scale of unit train operation. I think that is an economic bottleneck that will slow down the westward expansion of unit train operations.

CORPORATE PLANNING--
TRANSPORTATION DEMAND,
ENERGY COMMODITIES

Thomas M. Lydon
Vice President--Market Development
Peabody Coal Company

Presenter - Jerome Dotter

Following World War II the coal industry was a highly disorganized, fragmented industry with what appeared to be a bright future. But within a decade it had lost one of its largest customers, the U.S. railroad industry, to the diesel engine. That loss, equal to more than a third of the total production of the entire industry, occurred almost overnight. However, at about that same time the domestic scene was changing rapidly. Electric energy for the home and factory was being tapped as never before and the "American way of life" assumed zest and direction. Air-conditioning, or total weather control, became almost mandatory in the midlands and the sunbelt. An almost insatiable desire for energy then followed.

At first, coal enjoyed the benefit of the majority of this fast development of the electric utility industry, but along came a vast network of pipelines transporting gas to be sold at inordinately low prices. Again, the coal industry was fighting for its life. Through all this competition the industry survived by developing a rising rate of productivity, by producing more coal per day per man. One day, a man named Krushchev pounded his shoe on the table and said, "We'll bury you." At the same time the coal industry had the impression that the Chairman of the Atomic Energy Commission (AEC) was trying to tell us the same thing. Our electric utility customer was going to shift to nuclear power! In 1965, 16 of the 19 electric generators to be built in the Illinois coal basin were to be nuclear. The chief executive officer of a large western utility made the claim that the last fossil fuel plant had been built! We all know what happened. The coal industry survived again.

In 1969 the President announced that we had a need for an energy program, and the politicians since then have dallied with this notion. By 1975 the Arab oil embargo and the oil company response gave us vivid proof we did need an energy program, but the dallying continued.

About the time Nixon admitted the need for an energy program, the Congress decided we had a need for a more comprehensive environmental program. Since then, rules and regulations on the mining and burning of coal have made it very difficult to do either. Coal is surviving at a price.

This is the track we have been on for the past 30 years. How have we done it, and can we survive? I think we can. Remember, our basic product is a black, bulky, dusty product and is often located long distances from market. Other fuels were cleaner, handier, and frequently cheaper.

Coal has been moved to market, primarily, by railroads, and by barges on the inland waterways. However, some moves by belt, slurry pipeline, and truck. To reduce the cost of the delivered product, the railroads developed the unit train--a transportation concept that allows for the orderly, rapid movement of large volumes of coal in a single unit, not slowed down by switching and yarding practices of the system. Unit trains moved coal cheaper and faster than previous methods from mine to point of use. During the depression locks and dams were built on inland waterways (primarily the Ohio and Mississippi Rivers). These have since been expanded, and today a very large portion of coal produced moves on this system. Water transportation is cheaper than rail, but slower. However, once the "pipeline" is filled, it matters little. We move coal from Kentucky to Tampa in the South and to Minneapolis, St. Paul, in the North, in barges that also haul grain, phosphates, etc.

After the war, the orders for coal were seasonal and subject to the capability of small mines to produce. As the customer began to make commitments for larger amounts, over longer periods, long-term coal supply agreements began. The mining industry developed new and more efficient tools for use above and below ground. These allowed larger mines to supply the larger utility generating units through use of unit trains or river tows. There was a time when one could bid on some business (such as Tennessee Valley Authority) on a monthly basis, but this practice gave way to long-term contract buying.

All of this pushed our industry from what was a labor-intensive industry to become a very capital-intensive industry. In 1950, one could start a coal mine for a very low investment, about $3 to $5 per ton of annual capacity. Today, however, some $35 to $60 per ton of annual capacity is required to start operations. Today, one doesn't just sell coal, one must market it. Marketing is sometimes defined as the performance of business activities that directs the flow of goods and services from producer to consumer in ways that satisfy both. The known marketing factors are that the industry:

1. is demand limited;
2. is subject to politics;
3. has large reserves in the United States; and
4. has a positive future.

Coal has reached a new level of prominence because of the very positive promise and potential for America's energy future. The facts that there is an abundant supply of coal and that it is produced domestically make it a vital component of any new national energy program. It is interesting to note that, over the years, every economic model was using gas and oil as the base. If one looks at models now, the main sources of energy expected in the future are nuclear and coal. Even

though the past three Presidents have endorsed the expanded use of coal, there is stil no comprehensive energy program.

While President Carter is focusing on his energy program, his own administration is continuing to erect barriers impeding the coal industry. I will not belabor the negative aspect of coal's rebirth, but I must point out problems that government and environmentalists pose to the industry. However, I believe these problems are on the way to resolution. Let us, then, look at the positive aspects of the future for the coal industry.

Coal constitutes 60 percent of the energy in the nation's known and recoverable total fuel reserves, including oil, natural gas, shale oil, uranium, and other consumable resources. Coal represents as much as four times the reserve base as do the others combined. Coal is located in the East, South, Midwest, Southwest, and the Rocky Mountain areas of the country. The United States Geological Survey (USGS) has identified deposits in the trillions of tons. One-fourth of these deposits can be mined by present methods in today's economic climate.

This rich supply of domestically produced fuel is the reason coal is being cited as the base for the President's energy program. Coal, in its solid traditional form, can supply factories and electrical generating plants the boiler fuel they need for years to come. Also, coal in its potential gaseous and liquid forms could supplement our shrinking stocks of gas and oil.

Despite its potential, coal hasn't yet filled the energy gap, but that is certainly not because of any lack of reserves or lack of the ability of the industry to expand production and to transport the product. Coal's constraints have primarily been those of the market and those resulting from political decisions.

For most of its recent history, coal has been demand-limited. Americans have grown accustomed to using other fuels that were, at the time, cleaner, cheaper, and handier. When the coal markets were merely sufficient to require the coal available, operators had no reason or incentive to increase the amount of coal they produced. As an illustration, our industry right now has a capacity of over 830 million tons per year. We have demonstrated capacity of 775 million tons per year, and last year we produced about 700 million tons. As said earlier, we are demand-limited.

Much of the available coal remained in the ground because the demand was not there. Fortunately, that part of the equation is changing. The change is partly because of evolving government policies, but even more because utilities and industries now recognize that coal is the fuel they will need and use in the future. That estimate is not wishful thinking by the coal industry. It is a commitment backed up with firm contracts extending many years into the future.

Let us examine some figures that confirm my point. When we look beyond 1978, we see a sustained yearly growth in demand. Two recent National Coal Association (NCA) studies on the future production and use of coal through 1985 have indicated that, if government policies permit, President Carter's goal of 1.2 to 1.3 billion tons annually can be met.

The first study showed that about 100 coal firms are planning to open or expand 332 mines, which will produce nearly 600 million

additional tons of coal a year by 1985. Together with industry's current capacity to produce over 800 million tons yearly, that easily brings total planned production up to the President's goal, even after allowing for the closing of some of the existing mines.

The second study indicates that electric utilities, the coal industry's largest single customer (75 percent of production), are planning 241 new coal-fired generating units, which will use an additional 400 million tons of coal by 1985. This growth in new coal-fired units is not a consequence of government action or legislation, but a result of the free workings of the marketplace. For the last 2 years, there has been a very strong movement in the U.S. utility industry away from oil and natural gas and toward the use of more coal. A reflection of this trend is the fact that no new gas-fired power plants are projected to come on line in this country between now and 1985, and only a dozen more oil-fired generating plants will be starting up between now and 1983.

Coupled with a steady demand for coal by the steel companies and much greater use of coal by the other industries, these commitments by utilities make us confident that the President's goal of doubled coal production and consumption can be met.

The coal industry has made it so far, despite the loss of historical markets, despite cheap natural gas, despite nuclear energy development, and despite environmental movement. In the future there is hope for further development--gasification and liquifaction--and these will come simply because we have the reserves and the need.

DISCUSSION

MR. HAAN: Do you know how much oil is burned in eastern seaboard electric utility plants that could be replaced by coal?

MR. DOTTER: If I remember correctly, about 500 million barrels are burned by the electric utilities. Except for one case, where supply is by pipeline, these plants burn a residual oil that would require heating for pipeline movement, and therefore must transport it by other modes. So, if a utility burns oil as fuel, that oil is probably located very close to the ocean or to a navigable river. The primary flow of oil into the East and Midwest for utilities comes from the Caribbean. It is refined in the Caribbean, and probably produced in Venezuela, the Arab states, or Nigeria. For the West Coast, oil is produced in Indonesia, primarily, and refined in California.

To answer your question about how much oil could be replaced by coal, I would say that somewhere between 50 and 200 million barrels of oil might be replaced by some 16 to 60 million tons of coal. But this could be very costly, and I can't imagine any utility expecting its customers to pay for such a conversion. That is why we say it makes more sense to bring in new units. The utility industry is making a very strong commitment to coal and nuclear in the future, and a single unit of 1,000 megawatts will burn 2-1/2 million tons a year of eastern coal or some 3.8 million tons of western coal. The economics thus favor

using a single, new, large unit, as opposed to an older unit with all the problems associated with converting such plants.

MR. HAAN: Do you feel then, that the conversion of these eastern utilities from coal to oil may have had significant influence on the bankruptcy of the Pennsylvania Railroad?

MR. DOTTER: Without a doubt it contributed to it. I can't say that is the sole reason or the primary reason, because I haven't studied it carefully enough. The fact is, however, that the ConRail system (and mainly that part previously Penn Central) did serve the New York market, and a lot of the coal that was located on the ConRail system was a high-sulfur-content coal. Therefore, it could not meet the New York City's or the Boston area's requirements for low-sulfur coal, and again, partly for that reason ConRail did lose its market. In fact, in the final system plan for ConRail, it was expected that ConRail would share in the growth of coal in the next 5 years. ConRail has since revised that estimate. I keep a close check on the different railroads and their share of the market, and ConRail is not sharing in the growth in the coal market. The growth in the coal market in the past 5 years has been primarily in the western United States on such railroads as the Burlington Northern, Union Pacific, Missouri Pacific, and Kansas City Southern. It is true, eastern Kentucky has been a growth area, but aside from that location, eastern growth is stagnant. At least ConRail is holding its own now, and we don't find any more conversions to oil. However, we don't find any growth in ConRail's share of the coal transportation market.

Coal really has four markets--the electric utility industry, the industrial establishment including retail, the steel industry where the coal is used for coke, and the foreign markets. The utility industry is 70 percent of the market, and it is the only user that is expanding its requirement. The remaining users' requirements are steady or declining, but over the years we would expect their requirements to remain about as they are now. Even the industrial facilities, forecast by President Carter to increase consumption to 150-175 million tons of coal, currently consume about 60-70 million tons. Applying a standard projection, one doesn't see any basis for that degree of expansion. Industrial use simply is not growing, and the reasons for it are right in the pocketbook.

DR. GARRISON: I am interested in the uncertainties with respect to whether we will be hauling high-BTU, high-sulfur coal, or low-sulfur coal in the future. I would appreciate some comments about the environmental uncertainties, about allowable emissions in the utility industry, and how this might affect the hauling of coal from different regions. I am interested in how those uncertainties are affecting uncertainties in the pattern of investment in the industry, and, if there are uncertainties, how these affect the transportation industry.

MR. DOTTER: The uncertainty in the utility industry begins in 1984. From now through 1984, things are fairly certain. I would say there is an 80 percent probability that events expected now will occur up to 1984. Utilities, when building a power plant, must invest much capital, and in fact must know the fuel to be used before they even design and build the boiler, since it depends on the fuel. The degree of certainty drops as one projects further into the future.

To back up what I am saying, the Federal Energy Regulatory Commission has done a study that lists all the coal-fired units that are planned to start operating in the next 10 years. One of the amazing things revealed by that study is that by 1986 or 1987, 65 percent of the coal is already contracted for, and that tonnage is 414.9 million tons. For much of that tonnage the report reveals the location of the source of supply and the markets. There is a definite trend towards low-sulfur western coal. If one understands the utility industry, it becomes clear that must happen because the 1970 Clean Air Act applies now. The industry can't wait. They are a low-growth industry and they must serve their customers. The lights must come on or someone is going to complain, and the utilities will get "nailed" for it. The plants must be planned and begin operating, and that means with low-sulfur western coal.

I am not saying that it is all low-sulfur western coal. The data are in the study entitled "The Status of Coal Supply Contracts for New Electric Generating Units," put out by the Federal Energy Regulatory Commission. But the pattern is already there. While there will be some high-sulfur coal used in the Illinois Basin and in the West Kentucky area, scrubbers will have to be used, of course, to comply with the environmental standards. New units must meet the standard--no more than 1.2 pounds of sulfur dioxide per million BTU. In the next month or so, standards will change again. There may be confusion coming in the mid-1980's, when the Environmental Protection Agency (EPA) must tell utilities whether to go by the 1970 or the 1978 standards.

MR. MARGOLIN: Looking beyond the next decade, do you see any major transportation inhibitions in the coal production and coal distribution?

MR. DOTTER: If we go beyond 10 years, I really have to believe we are going to see slurry pipelines come into use, and for the same reasons we saw the unit trains. I think the economics of the situation will bring that change. There is going to be pressure by interests that used to build oil and gas pipelines and that will no longer be doing that. Those interests will want to put their money into something they can do, which is building pipelines, but for coal slurry.

At the same time, I hear from many coal producers that they are tired of not being able to get a supply of cars. That means they don't get paid for their product. Their customer is unhappy; they are unhappy. That problem occurs in the same regions year after year, but the only solution, if it isn't handled by the Interstate Commerce Commission (ICC) or the railroad involved, is going to be another mode of transport.

DR. BENTZ: What do you see as the potential export market for steam coal out to the year 2000?

MR. DOTTER: To give you some perspective, the basic export market for coal is for steam coal, and that represents about 60 million tons or 10 percent of production. Some 85 percent of that exported is metallurgical coal, that is, coking coal similar to that used in the steel mills. So we have a fairly small export steam coal market, and in fact most of that goes to Canada for use by Ontario Hydro for the production of electricity. Then, much of Ontario Hydro power ends up in New York State.

I think I can describe the future of the export steam coal market briefly by saying that those users will go for a cheaper product unless

we can lower our transportation costs and get the coal to the port at a competitive price, whether it is Australia or Canada or South Africa.

DR. MOSES: Do you view coal slurry pipeline construction and operation as a private investment carried out at private cost with a greater return earned in the market, or something to be paid for by government? And I couple that with the question of where the water supplies will come from in that calculation for the western coal.

MR. DOTTER: I view it as a commitment made by private industry as opposed to the government paying for it. And I also think the ground rules have to be set. I think private industry is waiting for that right now. Give them the ground rules to go by and at some point the pipeline will possibly become economically feasible. Clearly if the ground rules say no water, then a methanol mixture might be required, for example, and the economics would be changed drastically. But right now, there are no ground rules. One must go state by state for rulings. Eminent domain has been passed in certain states in the middle of the country, I believe in Oklahoma and Texas, and perhaps a few others. But private industry needs rules, and there are not sufficient rules there right now. If the right people in Washington, D.C., would make decisions and then stick to them we would be a lot better off.

CORPORATE PLANNING--
TRANSPORTATION DEMAND,
RAIL FREIGHT OPERATIONS CONSIDERATIONS

Michael M. Donahue
Assistant Vice President, Coal
Burlington Northern Railroad

Presenter - Gerald K. Davies

I know that there are some in the audience who have heard me offer Mr. Donahue's apologies in the past. I assure you he does exist--he is Assistant Vice President, Coal, of Burlington Northern Railroad--but he doesn't look like me at all. He did ask me to extend his apologies to the group for not being able to attend and make this presentation. It shows you exactly what can happen to the best planning around. We have had three sets of hearings going on in Washington in the last month, and we were quite sure that he was going to finish testifying in time to be here today, but the Interstate Commerce Commission doesn't believe our planning in that area either.

As an economist employed in the railroad industry, I stand before you today as a representative of both the dismal science and, based on what earlier speakers have said about railroads, the dismal industry. However, I will try to describe for you a little bit of what we do in terms of planning on the railroad, and what we see as some of the longer-term events that are probably more relevant to the context of this session.

Our basic corporate planning in the railroad focuses primarily on the volume, service, and equipment requirements based on the traffic patterns of our shippers as we see them for the relatively near term. That is basically a 5-year planning horizon. The reason for a relatively short planning span is that there is relatively little plant construction needed by the railroads in order to meet even major changes in shipper preference. We have a nation that is honeycombed with rail lines, and virtually every section of the nation is close to rail service.

That is not to say that in order to meet massive shifts in demand that you don't have to construct any rail facilities, either roadways or shops. We may, in fact, have to upgrade some lines in order to handle significant increases in traffic. But the longest-term planning horizon we are involved in is for construction programs. Our lead time, for example, for obtaining locomotives and freight cars at the present time is a little more than a year, and within that time we can, of course, develop the labor required to provide our maintenance and to crew our trains.

The one constraint that exists within that planning horizon is a capital constraint. We heard this morning, and I assure you that it is true, that the railroads, by and large, have a low return on investment (ROI) and have difficulty generating capital. In fact, most railroads are entirely excluded from the equity capital market. Burlington Northern is a recent exception to that rule. Last year, we did float a major equity issue, but it was not earmarked for general use on the railroad itself. That capital was intended to be used for coal-related projects, and it was the investors' belief that the major growth in coal that would occur in the next few years would justify the purchase of that equity issue.

But overall, our planning horizon is really relatively short. We can expand our plant capacity under load, and for planning even major plant capacity expansion we really need only about a 2-year horizon. For most investments, we can do the construction incrementally, while the railroad continues to operate. To start off, for example, we have to upgrade a line to handle the traffic that we see in the relatively near term. If the traffic continues to grow, we can add some sidings or lengthen some existing sidings. Eventually we may have to add centralized traffic control. And if we get a big boost in rail traffic, eventually we may have to go to double track. But all of those investments can be made while the railroad continues to operate.

In addition, one can coordinate, at least to some degree, the investment expenditures with the capital availability. In short, for the basic planning horizon, the certainty of traffic growth is the major issue, and not the ability to predict traffic far out into the future.

Coal, on Burlington Northern, is a good example of what I have just described. In the planning of the merger of the predecessor railroads to form Burlington Northern, a merger that occurred in 1970, there was virtually no consideration of coal traffic given in the planning for that merger. That is not because the planners were naive as to the amount of coal resources that existed in the West and, in fact, exist in large volumes on Burlington Northern's own property. It is because the coal is relatively low in BTU content compared to eastern coal, and it is also a long distance to anywhere from Wyoming.

Now, we knew that there was a lot of coal, low-sulfur coal (averaging about 0.5 percent). The changes that opened up the West involved a variety of factors. Of course, we had environmental concerns that raised the importance of low-sulfur coal. We had the energy shortage that boosted the need to use coal. We also have a high level of productivity in the western coal mines. These are surface mines and productivity is in the range of 100 to 150 tons per man shift, as compared to 6 to 12 tons per man shift for an eastern deep mine. The result is that the coal at the minehead is relatively cheap compared to eastern coal. Right now, the best estimate I have is that western coal costs about $7 a ton, which is between one-third and one-quarter of the cost of eastern coal.

On the other side of the ledger, as I said, it is a long haul to virtually anywhere from Wyoming. Our unit coal trains on the Burlington Northern have an average round trip of about 1,600 miles one way. As a

result, the cost of transporting the coal often exceeds the price of the coal itself, even though we do move virtually all of that coal in unit trains that consist of 100 to 110 cars, 100 tons per car, which totals between 10,000 and 11,000 net tons per train.

In 1973, the Burlington Northern originated about 25 million tons of coal on its lines. By 1977, that had grown to 51 million tons. That is a little over a 100 percent increase. Right now, we are estimating that by 1982 we will be handling between 125 and 140 million tons, that is between 127 and 177 percent above 1977. And as I said before, virtually all of that coal will move in unit trains.

In terms of planning for the coal volume on Burlington Northern, we have what I guess is the normal planning cycle for a railroad. We start out on the marketing side of the company, with the marketing department developing tonnage projections by origin, destination, and by route of travel. We do that for all commodities. For other than coal, we really start out with the Wharton model for a general picture of the overall economy for the planning period. We then go through a series of field and headquarters reviews in the process of developing a 5-year plan.

The procedure for coal is really quite different than for most commodities. Because it takes so long to build a power plant and to open a new coal mine in the West, we know what volume to expect well in advance of the actual initiation of the shipments. In the normal course, we are alerted approximately 4 years before shipments are actually to begin, and we have discussions with the shipper and the mine about the volume that is expected, how the volume would be handled on the railroad itself, and what the rate might be.

With respect to forecasting, we know with a fair degree of certainty what the coal volume will be for the next 5 years. That makes the planning easier in one sense but somewhat more difficult in another, especially on Burlington Northern, because of the need for detailed capacity analyses and planning. When we started the planning for coal in some detail, basically about 3 years ago, the management found it difficult to believe that coal usage was going to grow as fast as was projected. The forecasts were just about right on the mark, but it was hard to believe that coal demand could grow that fast. Things don't change that fast on railroads, especially not today, unless you are predicting a decline.

So what we do with those coal volumes first is to give the projected coal volume to the engineering department. They go through three steps involving the use of a series of computer models in the form of a train performance calculator and a line capacity model to identify what general major capacity expansion projects may be required to handle the growth in tonnage, not just coal, but all freight over each line segment on the railroad.

They then manually review the lines in light of the projected volume to make sure that the computerized process hasn't overlooked the required replacement of a bridge or some similar factor. The projections then go into the transportation department for the development of estimated train miles, fuel requirements, locomotive requirements, and facilities for maintaining the plant and equipment.

In the normal course, our 5-year projections are developed by field officers and are reviewed and synthesized in the headquarters. Coal is not handled that way because most of the information about future movements is developed at headquarters and then reviewed with the field officers.

As I said, few of the projects to expand capacity on the railroad really involve very long lead times. In some cases, we do have to construct long lines. We have one that is about 120 miles long that we have been building for about 2 years. That does involve longer lead time, because of the need to plan the line, to do the environmental impact statements, and to get Interstate Commerce Commission approval to build new rail lines, not sidings, but rail lines. It also takes a little bit longer lead time to build a major shop. But again, cars and locomotives can be added basically with about a 1-year planning horizon.

Now, with this planning in mind, we have undertaken a large amount of capital expenditure on the Burlington Northern in the past for coal, and we plan to spend a good deal more in the future. Between 1973 and 1977, we invested $440 million to handle coal; $201 million of that was for plant, and involved 146 miles of centralized traffic control, 915 miles of re-layed track, and a new bridge at Rulo, Nebraska. We then spent $239 million for equipment. That included 323 locomotives, 3,200 cars, and 68 cabooses.

During the next 5 years, 1978 to 1982, we are going to be spending another $1.25 billion just to handle coal. That will include $937 million for the plant itself, including 2,300 miles of re-layed track, 572 miles of new tracks and sidings, 1,100 miles of centralized traffic control, a new rail welding facility, new fueling facilities at three locations, and a large new car and locomotive repair facility at Alliance, Nebraska. We also intend to spend about $340 million for equipment, which includes 409 locomotives, 1,200 cars, and 140 cabooses.

In addition to our investment, as has been alluded to earlier today, the shippers also have a substantial investment involved, because most of our utility shippers buy their own freight cars for the coal moves.

Generally, what I have tried to explain is that the planning horizon for most of our work on the railroad is 5 years or less. The 15- to 20-year planning horizon that has been discussed for this conference really is more relevant to changes that are occurring in the structure or the nature of the economic-political-institutional framework within which we must be prepared to operate. One of the major considerations that you get into, of course, is energy. On the coal side, we are quite concerned with keeping track of where the energy requirements in this nation are going in terms of location and type of demand, and we are all well aware of the Administration's goal to substantially increase the production and use of coal. Incidentally, when the President's plan was announced, as was mentioned earlier, there was quite a bit of discussion about the increased industrial use of coal. Virtually all of the coal growth on the Burlington Northern, however, has gone to electric utilities. We have seen virtually none of the growth going to industry.

We also must keep track of the energy availability by type of energy--oil, gas, nuclear, and coal--and with respect to coal, we must be aware of the locations of the energy reserves and what uses could be made of the various types of coal. Our western subbituminous coal is relatively low BTU, but it can be used in most existing coal-fired boilers. Lignite, on the other hand, is not generally usable in existing boilers, but it is nearly an ideal fuel for use in coal gasification. It is going to be interesting to see what happens in those areas.

Of course, what happens in the future is going to depend rather heavily on the relative and absolute prices of the various fuels. Technological factors are also going to play a major role in what happens downstream with respect especially to the relative ease of substitution for different uses of the various forms of energy, including the various types of coal. Those impacts are going to evolve from a variety of factors, including the locations and the magnitudes of the sources and uses of coal, relative fuel costs, and the relative ultimate total cost per unit of energy delivered.

Another element that is of concern to the railroad is the modal split in the distribution of energy, whether that be rail, truck, water carrier, transmission line, or pipeline, including slurry. Again, the relative uses of those modes is going to depend on the cost of their services and the location and sources of demand and the volume involved. And coal gasification may well change a variety of the markets that we see right now for coal.

We don't think, as was discussed earlier, that we are going to see very much in the way of mine mouth electric power generation coupled with long distance transmission lines. We in Minnesota have witnessed a great deal of travail during the last 3 or 4 years over the construction of power lines from North Dakota into Minnesota. There has been a lot of resistance both by urban and rural populations along the route of that transmission line. We think that is going to get more severe as time goes on and really don't think there is going to be much in the way of mine mouth generation in the West.

The other factors that we have to be well aware of are the institutional and political changes. We all have to live within the framework that involves political concerns. We also live in an era right now where we are very concerned about environmental factors, and, as was alluded to in an earlier presentation, the impact of the recent environmental regulations really is unclear at this time. We are not sure what is going to happen either to the demand for coal in total or for the demand for western coal specifically. We do know that it is going to change. We are going to have to watch how it unfolds.

Another element of concern in that vein involves the mitigation of socioeconomic impacts on energy boom areas. We see a number of towns, for example in the Powder River Basin area that we serve, that have experienced extremely rapid growth in the last few years as the coal mines in those areas have developed and as the rail service in those areas has expanded. Many of those small towns simply have been unable to keep up with the population change. For example, right now, a large proportion of the population in Gilette, Wyoming, is living in mobile homes. There simply isn't sufficient permanent housing.

Another element in the socioeconomic area that we are becoming concerned with now involves grade crossings. Many of the small towns are used to seeing one or two trains a day, but, with the increase in train traffic moving out of those relatively sparsely populated areas, the change can be perceived as significant.

An additional element that we are quite concerned with in the railroad industry, too, is economic regulation. It impacts us rather severely, because we are very heavily regulated at the federal, state, and local levels.

What happens is that that regulation severely restricts our ability to respond to changed market conditions. We have to recognize the change and prepare plans to respond to it. Then we have to sell those plans to an Interstate Commerce Commission, and that is more difficult than some of you might realize.

We also are restricted in our ability to obtain the rate levels that are necessary to support the massive amount of capital investment that we are making and are going to have to make to handle coal, not only today, but in the future. We can get legislated changes in the economic regulation that will change the framework within which we operate, but I think the experience with the Four R Act, also talked about earlier today, has proven that the ICC has an ability to reduce or virtually eliminate a lot of potential benefits contained in legislation of that type. I don't see any reason to expect that will change in the future.

Also on the economic regulation side, we now have what is called Ex Parte 347, which is a western coal-rate structure investigation that was recently initiated by the Interstate Commerce Commission. They are going to get into a variety of issues there, including the zone of reasonableness that may be applied to our western coal rates. There is actually a list of seven issues that they hope to explore through that proceeding, all of which are extremely complex, and I doubt they are going to be settled any time soon.

As a companion issue, the commission has stated that it is considering a policy change that would allow the railroads to enter into contracts for the delivery of coal, as an example. I am not sure now where that investigation is going to lead us. At this time, a majority of the benefits available from the high-volume movement of coal on a regular schedule has already been passed on to the shippers in the form of their rates. In essence, then, what benefit can we achieve now from contracts?

Perhaps the only benefit left to the railroad is that a contract rate would give us collateral for use in obtaining financing, but it depends--the usefulness of that sort of a contract really depends on what kind of rate authority the commission maintains over the rates quoted in those contracts.

Personally, I suspect that by the time it is all over, contracts will prove of little use to the railroads.

There are a variety of other factors that are involved on the institutional side. The development of our nation's coal resources is moving more slowly than many had predicted. When it was announced that a national goal would be to increase our coal production from about 665

million tons in 1976 to 1.2 billion tons in 1985, everybody thought there would be an enormous bonanza. In fact, there has been a bonanza of sorts in the West. The original estimate was that two-thirds of the growth in coal, or about 400 million tons of the increase, would have to come from the West, which produced only 127 million tons in 1976; but as I said earlier, the impact of the environmental regulations is going to slow that development. We also have a variety of additional factors, including the federal policy on the leasing of coal lands that is slowing up the development of western coal. The federal government owns a tremendous amount of the coal out there, and, in order to put together an economic mining package, one often must have at least some access to the federal coal deposits.

Another element that we are watching very closely on the Burlington Northern is the extent to which there is public financial involvement in the railroad industry. Our concern really goes beyond the level of involvement that already exists in the form of AMTRAK and ConRail financing and the financing going to the branch lines. Mr. Davis talked earlier about a $200 million loan of federal funds that would go to a major solvent carrier. We at Burlington Northern are quite concerned about what that portends for the future. Of course, with federal money comes a great deal of federal control in the operation of that particular railroad, and we are concerned about the trend and where it may be leading the industry.

Of course, with respect to the railroad industry, I assume that everybody understands how interrelated the industry is. We both compete with other railroads, and we must cooperate with other railroads in order to meet the transportation requirements of our customers. But some of the railroads on whom we depend are bankrupt, and some of them are in a very tenuous financial condition. There are a few that are in relatively healthy condition, but as the saying goes, the chain is only as strong as the weakest link. If we can't depend on our connecting carriers to provide quality service, it is hard for one carrier to try to significantly improve its quality of service.

Right now, the railroad industry is characterized by a large amount of route mileage, which has the effect of fragmenting traffic flows. The result is to increase our cost of production and to reduce our ability to compete. This is especially important given the financial condition of the railroad industry itself. We also have an excessive number of firms in the industry, and that fragments any response that we may have to changed economic circumstances.

We also have a fragmented view of the role of railroads themselves in the future.

With respect to very long-range planning, economic regulation is a very serious constraint that we have to deal with. It limits our range of actions and extends our response time. It also fragments and drains our financial resources. There is another element; railroads historically have been viewed as instruments of public policy and tend to be on the tail end. For example, we are asked to hold our rates down to reduce the impacts of inflation on shippers at a time when the industry is suffering from inflation and doesn't have the capital to make the investments required to meet the shippers need for service.

Over the long range, I think we are going to see a trend to a very few large rail systems in this country. The result will be to reduce the physical plant of the industry and the balkanization of the industry. It will reduce the fragmentation of our available resources, and it will increase our ability to respond to change.

By doing those things, we will improve our efficiency by consolidating traffic flows, which will give us lower cost and a chance to offer better service. I think there is also going to be a significant trend toward minimizing our dependence on the weak railroads, railroads that can't perform. And I believe that railroads will reduce their dependence on individual commodities or individual production areas, essentially diversifying the traffic base. I think the proposed merger between the Burlington Northern and the Frisco exemplifies that kind of diversification.

Essentially, the proposed merged system would mingle service territories with different traffic bases. We think it would be better for both of us. Of course, the structure of the systems that ultimately comes out of this process is going to depend on the industry's perception of location and structure of our sources of raw materials and the users of those raw materials. It will depend on our nation's energy policy. It will depend on our federal policy with respect to economic regulation and environmental and safety regulation. So the issue that is facing the industry today, and that it has faced for some time, is exactly what role will rail service play in the future area and regional economic structure of our nation. And, we can't answer that today.

DISCUSSION

MR. PERRY: Have you had, or do you expect to have any trouble blending in large volumes of unit train coal traffic with your other traffic? Operationally?

MR. DAVIES: Operationally, it depends on the area. The routes that are traveled by our unit coal trains had adequate capacity to handle the traffic that existed prior to the growth in coal. Coal on Burlington Northern basically follows three corridors. We go north out of the Powder River Basin, or follow a northern route out of the Powder River Basin, through North Dakota and into Minnesota. On that route, we do get into some traffic congestion, but at this point it is not severe.

The second flow is to the south through Colorado and into the Texas corridor. Again, that is a relatively light corridor on Burlington Northern, and we don't now have any major constraints, except in a few areas such as Denver.

The other flow is through the central part of the system, into Illinois, for example. And until you get into the area west of Lincoln, Nebraska, there is no particular problem with other traffic flows. Our basic problem on the system right now is getting the coal out of the

coal mining area itself. The area between Powder River Basin and Lincoln or Denver is our biggest bottleneck at this time, because of the high traffic volume and because we are constructing additional capacity under load. We are making the investments, not just between the mines and Alliance but over all of our coal routes, that we think will provide the necessary capacity for the future.

MR. PRIMAS: With the coal activities, what is the prognosis for the rate of return and the profitability of the Burlington Northern in the next few years?

MR. DAVIES: I wish I knew. We certainly do have a major opportunity on Burlington Northern right now. It is an opportunity that does not face other railroads in the industry. We do face a proposition where we will have substantial traffic growth, new traffic added to an existing system. We do have a potential, therefore, for increasing our rate of return. Whether or not that will come about depends more than anything else on commission action. Whether we can get the kind of rates we need out of the Interstate Commerce Commission is really the question. And if we don't we all are going to have to curtail investments, which is going to limit the industry's ability to handle the coal in the future.

MR. HAAN: We do a little shipping on your railroad, too. We think it is a very good one. I have a little bit of a problem with your feelings about regulation, and I am wondering if you think there is any difference in commission regulation of manufactured goods, which may have a competitive mode available to them, and bulk shippers, over whom you hold a monopoly kind of market dominant position? Don't you feel that in a monopoly position there is a need for maximum rate regulation?

MR. DAVIES: I would agree, I suppose, that there is a need for maximum rate regulation if we ever reach the position where we were making an exorbitant rate of return. I don't know of any shipments, certainly on our system, where that occurs, either for individual shipments or for major commodity groups. Personally, I think that there is no doubt at all that we are going to have maximum rate regulation. There is simply no question about it. The issue that has to be settled is what the maximum rate ought to be. Now, as part of the Ex Parte investigation, I understand the commission is going to initiate investigations into a series of what they have called high-rated commodities. I haven't seen the order yet; I have only talked to a couple of lawyers. I think that is the wrong end to start at. I would rather see an investigation in the low-rated commodities and get them boosted, but that is my personal opinion.

DR. BENTZ: Since you are a member of one of the more successful generators of capital to meet anticipated coal demands, I would like to ask what you see for both the eastern and the western movements of coal, for the projected needs in capital for the railroads to meet these demands? Further, what financing mechanisms do you feel will be most amenable to the railroads, both the railroads in the West and the East in order to generate this capital?

MR. DAVIES: It has been some time since I have been deeply involved with railroads in general. I have recently been very busy on Burlington

Northern itself, and I really haven't had time to get into the details of industry-wide issues. But personally I think you are going to continue to see that virtually the only source of capital available for railroads is internally generated funds. It is true that Burlington Northern was successful in selling an equity issue. I would like to think that we could do it again today, but on Burlington Northern most of our financing will be through equipment trusts or leases for the rolling stock; and, for the plant, the majority of the investment funds is going to come from internally generated sources.

DR. MOSES: I have a question for you which is really, in part, to a former questioner. It has been argued that regulation is needed because there is cross-subsidization, and that commodities on which you have a monopoly position allow you to then carry other things in which you don't have a monopoly position and, in fact, may be losing money. So now it turns out that you have a commodity in which, in the short run, there may be some profit to be made. What about the longer run? Is there not a potential for competition in the movement of coal to alternative markets? We have seen in the movement of agriculture commodities, for example, that they are going 700 to 800 and more miles by truck. Why do you accept the designated, by definition, assumption of monopoly? I wouldn't do it if I were you.

MR. DAVIES: I had an internal reaction to the term monopoly, but I let it stay there. I don't believe that the railroads have a monopoly in anything, either in the short term or in the long term. I don't know how many of you are aware of the San Antonio litigation that has been going on between Burlington Northern and the city of San Antonio involving the rates for moving coal. We have heard in that case a lot of evidence about the railroads and their monopoly position, and we were gouging everybody and making a lot of money.

The statement essentially is that the city of San Antonio is at the mercy of Burlington Northern, and therefore the commission ought to hold down Burlington Northern's requested rate. At the same time, San Antonio has said that if that rate is granted, they may be forced to convert to gas or oil. How can a claimed Burlington Northern monopoly position be consistent with their stated ability to convert to an alternative fuel? I don't think we really have a monopoly anywhere. We might have a monopoly for operation with one customer over a short period of time, but not in the long run. We just don't have that economic force. Nobody in the railroad industry does.

DR. HERWALD: If the rate increase you are requesting is about equal to the price per ton of coal, and you expect to invest about $2 billion, it is hard to see how that gives an adequate return on investment. Is that true?

MR. DAVIES: Part of what we have done in working on the coal rates is to take the expected future investment cost and translate that into a level annuity per ton based on what we figure is our cost of capital today. That capital cost is about 11 percent, compared to our 2 percent rate of return. We then added that level annuity per ton to the overall rate. The commission then said, "No, you can't do that. You can't add prospective investment costs into your rate base at this time. If you

make those investments in the future, then you come back in for an increased rate which may take 2 or 3 years to get, and then if you make some more investments you come back in and ask for another rate increase which may take you another 2 or 3 years to get."

MR. HAAN: I am sorry to bring this back up again. I am not a professor of economics or of transportation at Northwestern, but I just ask the question whether you think that a commodity that pays 300 percent above variable costs is one that indicates that you have a monopoly? and secondly, if you are hauling--I guess out of the Powder River Basin, I would say anything over 500 miles--if you are hauling 100 percent of it, do you feel you have a monopoly there?

MR. DAVIES: No, I don't. Let me answer your first question first. If we had a rate, and I emphasize the "if," where the rate was 300 percent of variable cost, we probably would have a short-term monopoly. I would like to see your definition of variable costs first. On the second question, we may have a monopoly in that kind of a movement for a very short period of time, but there are alternate sources of coal and there are alternate fuels that San Antonio, for example, can use, and they haven't been a bit shy about explaining that to us.

CORPORATE PLANNING--
MOTOR CARRIER FREIGHT DEMAND,
LONG RANGE PLANNING

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INTRODUCTION

The purpose of this conference, as I understand it, is threefold:

1. To forecast long-run trends in freight transport demand.
2. To identify and discuss the factors and uncertainties that will affect future transport demand.
3. To suggest research projects that should be sponsored by DOT in preparation for this changing freight transport environment.

Since it is difficult to discuss each of these three topics in isolation from the others, this paper will treat them as a single purpose. Furthermore, I will concentrate my comments on the demand for motor carrier freight transport, especially LTL (less than truckload).

ECONOMIC FORECASTS OF TRUCKING TONNAGE

The IU tonnage forecasting model shows general freight trucking growth lagging economic growth through 1984, which is the horizon of our current strategic planning process. However, as can be seen in Figure 1, the model shows truckload closely paralleling the economy (measured by industrial production) throughout the strategic plan period. The sluggishness in forecasted growth is being caused by LTL, as can be seen in Figure 2. LTL growth has lagged economic growth throughout the 1970's and is forecast to do even less well into the 1980's.

I will discuss the LTL growth problem in more detail later in this paper. However, it is instructive at this point to examine the components of the forecast.

As can be seen in Table 1, industrial production is the most important explanatory variable for truckload, while capacity utilization is the most important for LTL. The Chase Econometrics forecast calls for moderate economic growth, but no substantial improvement in capacity utilization.

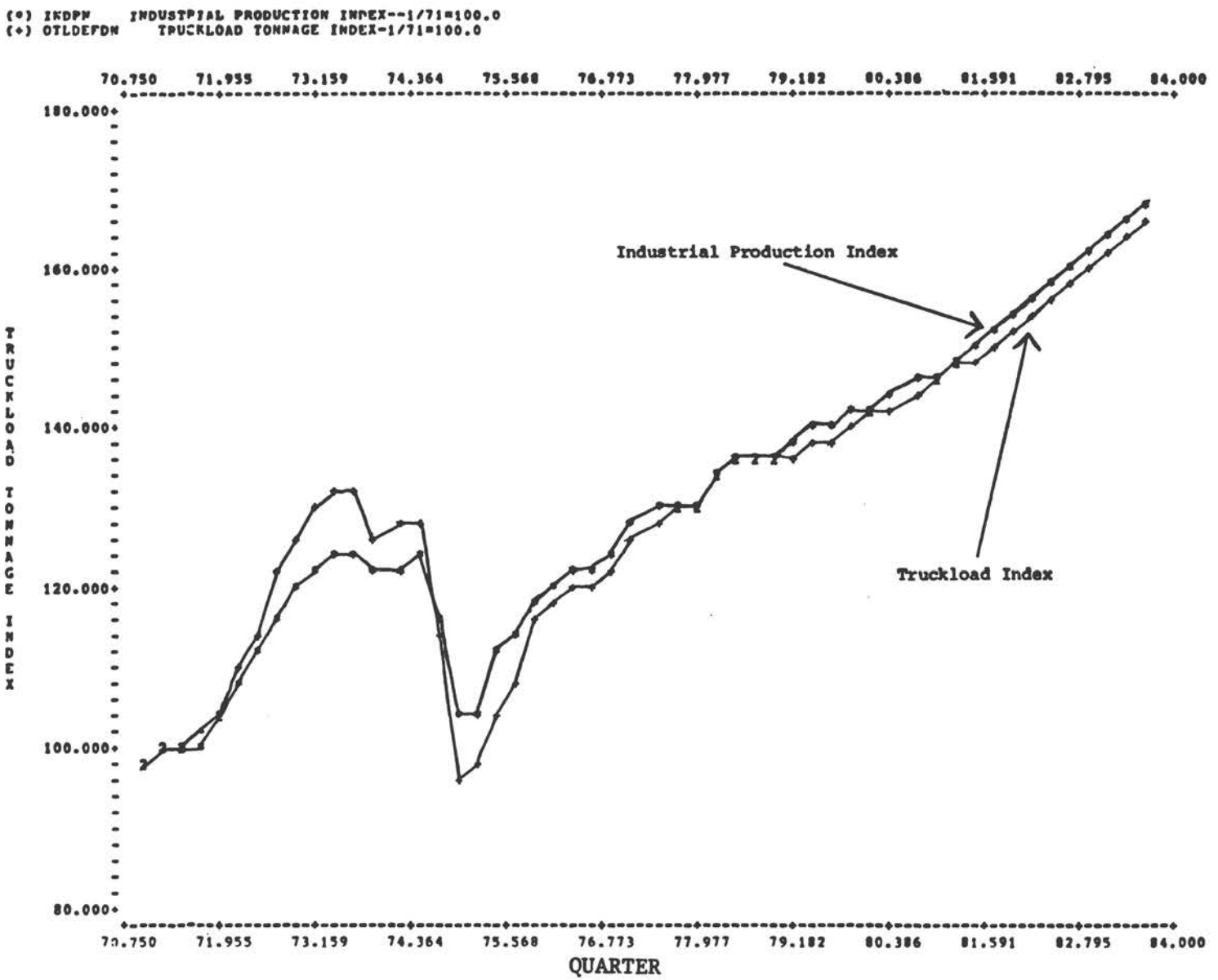


FIGURE 1 Truckload Tonnage Vs. Industrial Production Index, 1971-1984
SOURCE: IU International Management Corporation, 1978

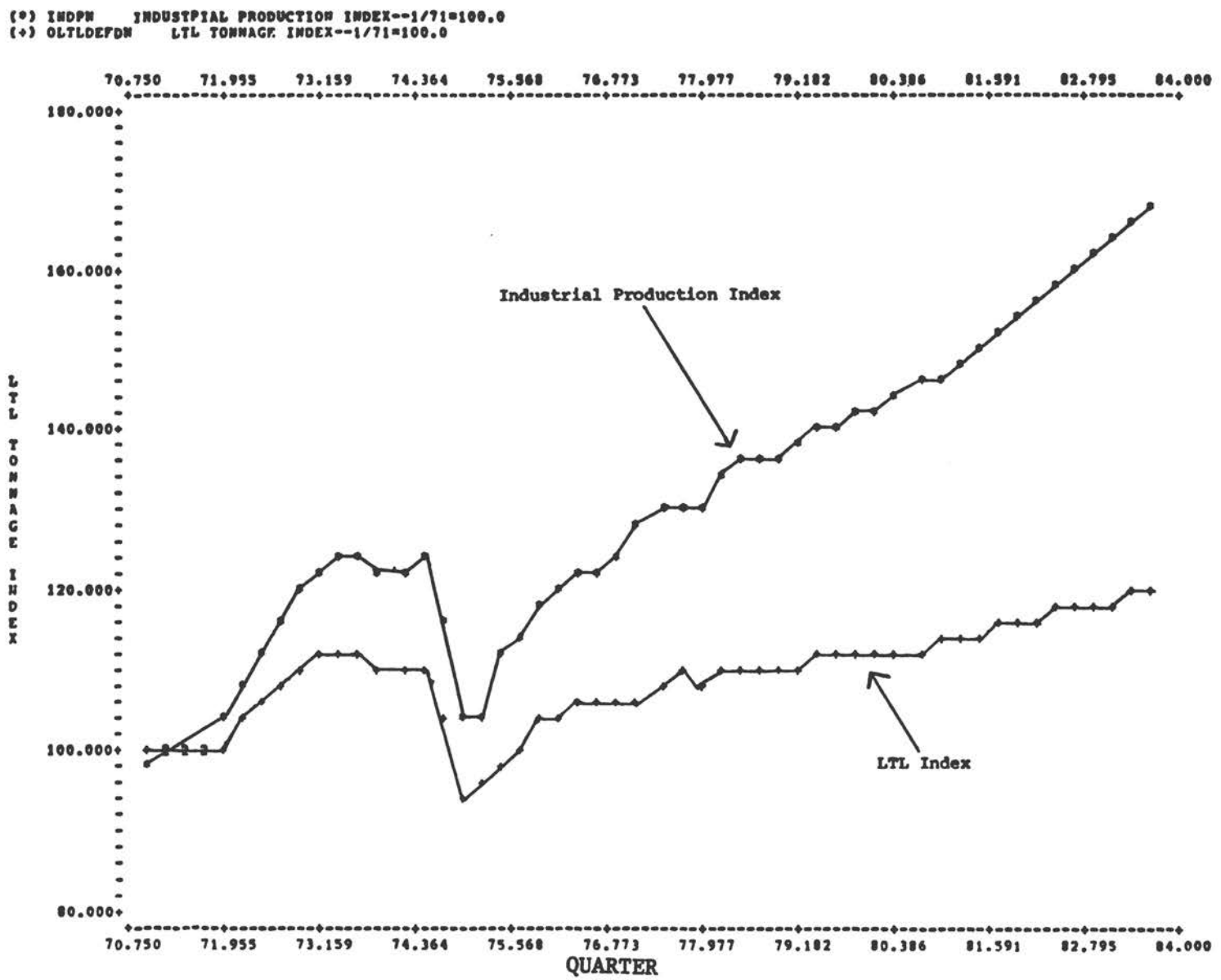


FIGURE 2 LTL Tonnage Vs. Industrial Production Index, 1971-1984
SOURCE: IU International Management Corporation, 1978

TABLE 1 Relative Importance of Explanatory Variables to IU Model Forecasts of TL and LTL

	Importance		Chase Forecasts	
	TL	LTL	1978	1984
Industrial production	0.64	0.41	143.0	188.3
Change in inventory	0.11	0.13	NMF[a]	NMF[a]
Capacity utilization	0.25	0.46	83.9	83.5

[a] NMF - No meaningful figure

SOURCE: IU International Management Corporation, 1978.

The importance of capacity utilization to LTL growth is worthy of note. LTL growth is strongest when the economy is overheating. Bottlenecks develop in supplier industries, backlogs build, and industrial shippers are enormously more willing (and often required) to use premium forms of transportation. Furthermore, the industrial durable equipment sector is strongest during the boom stages of economic recovery, and a much larger proportion of those commodities move by LTL trucking. If Chase Econometrics is wrong and there is a boom stage in this economic recovery, LTL growth could be stronger than we have forecast.

However, this improvement would only be transitory. The long-term secular trend for LTL is not good, as shown in Figure 3.

ASSUMPTIONS OF THE ECONOMETRIC FORECASTS

We build econometric forecasts as a necessary input in our strategic planning process. However, all that we will say with certainty about our forecasts, or anyone's, is that they are wrong. Consider for a moment the implicit assumptions of our tonnage forecasts:

1. The impact on trucking growth from structural changes in the economy and from changes in the market channels of distribution will be approximately the same from 1978 to 1984 as they were from 1971 to 1977.
2. Rate increases in general freight trucking relative to rate increases of competing modes (including private carriage and other sectors of regulated trucking) that existed in 1971-77 will continue in the period 1978-84.
3. The relative rate increases between LTL and TL (truckload) within the general freight industry will be approximately the same in 1978-84 as in 1971-77.
4. The sensitivity of demand for general freight trucking services to relative prices (cross-price elasticity of demand between general freight trucking and its competition) will be the same in 1978-84 as in 1971-77. Similarly, the cross-price elasticity between LTL and TL will remain the same.
5. Trucking management practices that influence industry growth rates (such as freight selectivity programs) will have approximately the same effect on tonnage growth in 1978-84 as in 1971-77.

Each of these assumptions must be viewed with caution. Note that while the values assigned by other forecasting models to these assumptions may be different, every model at least implicitly must deal with these assumptions. In the remainder of this paper, I will discuss the three assumptions I find most worrisome.

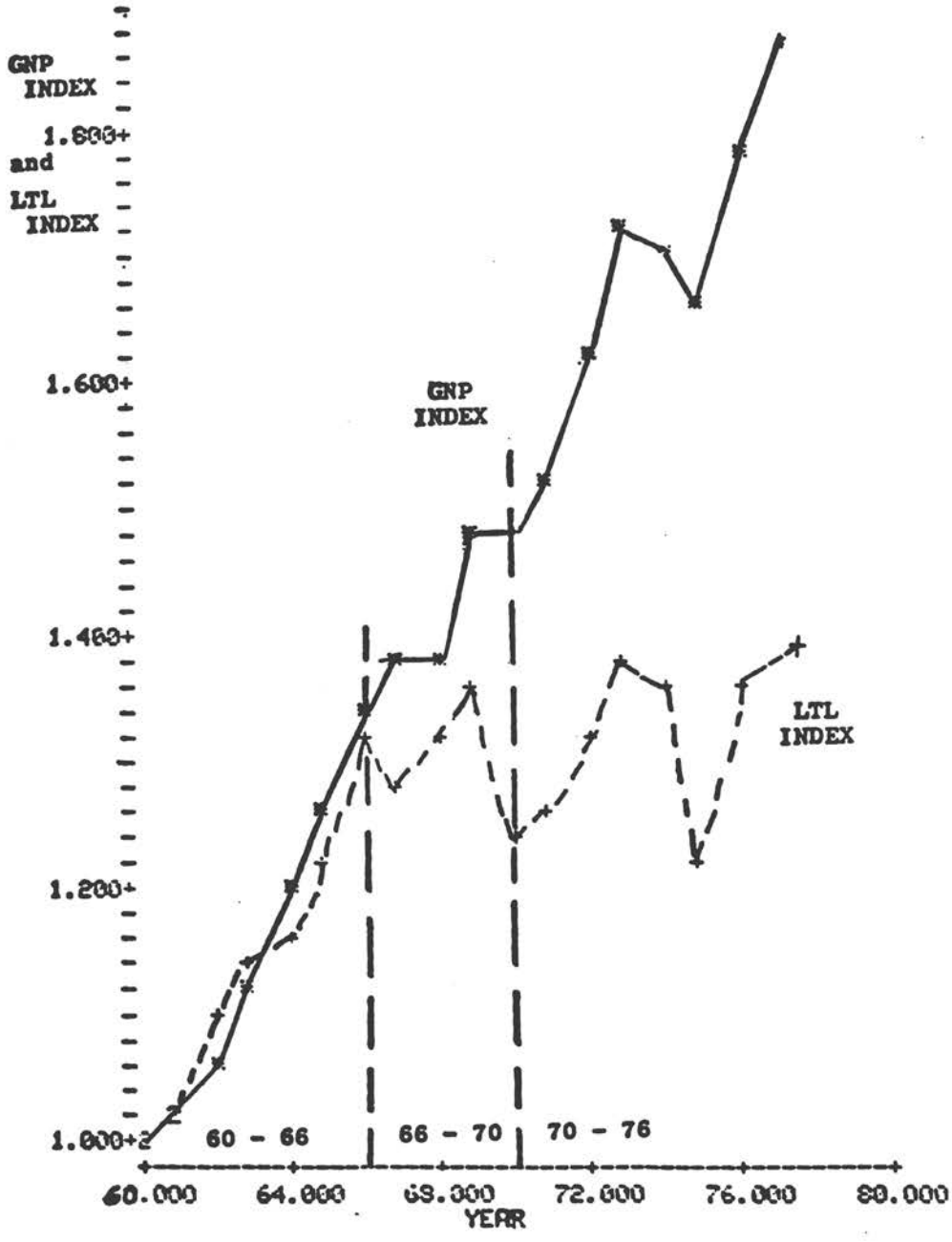


FIGURE 3 LTL tonnage growth vs. economic growth (real GNP), 1960-76
SOURCE: IU International Management Corporation, 1978.

STRUCTURAL SHIFTS IN MARKET CHANNELS OF DISTRIBUTION

One reason that growth trends in motor carrier freight transportation are so difficult to analyze is that there is very little data concerning the role that freight transportation plays in the various links of the nation's distribution system. Figure 4 is an oversimplified schematic of market channels of distribution--the processes by which products are moved from producer to user. Think of the connecting edges in this exhibit as distribution linkages--the elements that bind the sectors of the economy together. The revenues and profits of trucking companies are much more sensitive to certain of these linkages than to others, and the importance of each linkage is very different for truck and rail freight and also very different for TL and LTL trucking.

In the long run, shifts in market channel design and physical distribution system design will have a dramatic influence on the growth and health of the trucking industry. However, as transportation planners, we have only vague impressions concerning the relative importance of each link in the total freight transportation market.

It is generally recognized among marketing experts that there have been substantial shifts in the channels of distribution in recent years. One such shift is the more careful planning of the number and location of field distribution facilities. For many years now, the trend in

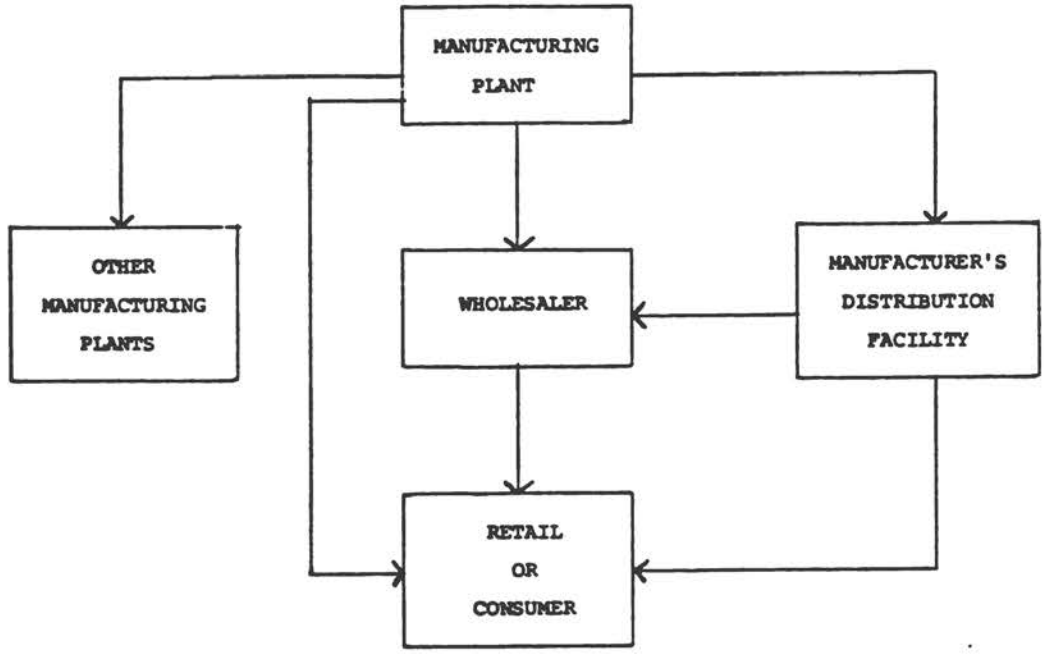


FIGURE 4 Simplified flow diagram of links in market channels of distribution. SOURCE: IU International Management Corporation, 1978.

many industries has been to close large numbers of "local" warehouses and to reconsolidate these inventories at a limited number of large regional distribution centers. Other industries that had traditionally shipped to customers directly from plants have also opened large regional distribution centers.

Figure 5 is a generalized relationship between LTL freight payments to motor carriers and the number of freight locations in a firm's national distribution system. Although we are not sure of the precise slopes of these curves, we do know that LTL revenues, especially in the 500-mile and longer length-of-haul market, drop dramatically in systems that expand the number of distribution facilities. Incidentally, the fact that a large proportion of these new distribution facilities are built without rail sidings may help explain the relatively rapid growth of truckload compared to the slower growth of LTL and rail freight. We

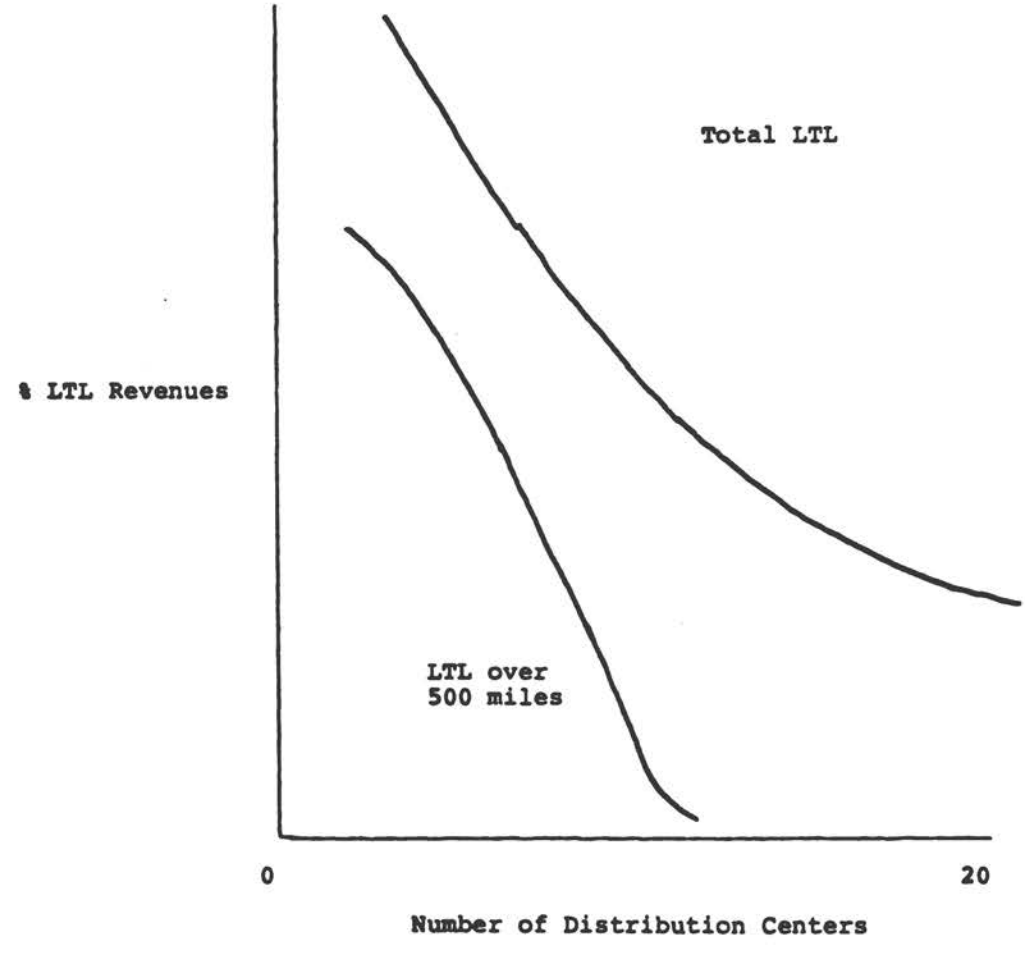


FIGURE 5 Changes in LTL share of freight revenues as number of distribution facilities change. SOURCE: IU International Management Corporation, 1978.

must have a much better handle on the importance of each of these distribution channel links to the various sectors of freight transport and then study the changing patterns in and among links. I recommend that research on this general problem should be on the top of the list of research projects that we submit to DOT.

I have made a rough first cut at understanding the varying importance of different distribution links in trucking. The outbound data in Table 2 was developed by reconciling sources such as the Census of Transportation (Commodity and Truck Surveys), Trinc's ICC Freight Commodity Statistics, import/export statistics, and the tariff bureau rate increase justification statement filed with the ICC. As you can see, 54 percent of ICC regulated trucking activity originated at manufacturing plants and 29 percent from intermediate points in market channels. Many trucking firms use regional measures of manufacturing activity as

TABLE 2 Sources of Regulated Intercity Trucking Freight, Outbound

Outbound Source	% of Market
Manufacturing plants	54
Distribution centers and wholesalers	29
Imports	5
All other	12
TOTAL	100%

SOURCE: IU International Management Corporation, 1978.

a surrogate for outbound trucking, and this data suggests that it is a bad surrogate.

The inbound data in Table 3 was developed by processing a 50 percent sample of general freight industry outbound commodities through government input/output tables. Note carefully that since input/output analysis ignores intermediate distribution, freight destined for wholesalers and distribution centers is attributed to their ultimate customers.

The inbound data is especially interesting. It is normally presumed that general freight trucking moves finished goods, predominantly to the consumer sector. As can be seen in Table 3, consumer goods are a surprisingly small percentage of trucking inbound freight. The relatively high proportions of inbound freight to the manufacturing, services, and construction sectors are also surprising. Many truck lines use retail sales as a surrogate for inbound trucking, which is a very bad surrogate.

Structural changes in the economy that will affect the relationship between economic growth and trucking can be considered in the light of the three most important inbound sectors to trucking:

1. Consumption. Retailers are increasingly becoming the "captains" (channel leaders) of the channels of distribution for consumer goods. Transportation/distribution inefficiencies once caused by the fragmented control of the flow of goods among channel participants are being eliminated through the insistence of channel captains (increasingly giant retailers) on the most efficient possible distribution systems.

2. Construction. Here, too, this industry has undergone a substantial consolidation. Large construction firms now represent a very large percentage of this industry, and the greatest influence of these firms on market channel and distribution systems design in the construction materials market is probably yet to come.

3. Manufacturing. Trucking growth was aided in recent years by a shift of manufacturing activity from old plants in industrial centers (generally in the Northeast) to more geographically diverse points. Furthermore, the percentage of new plants that have rail sidings is much lower than in previous generations.

These changes in the retail, construction, and manufacturing sectors are just examples of the types of structural changes in the economy that can cause historically based econometric coefficients to generate bad forecasts.

As an isolated thought concerning shifts in market channels, it is popularly believed that while integrated physical distribution systems are a competitive threat to LTL transport in consumer nondurable markets, the industrial markets are relatively immune to such competition. The evidence does not support this belief. Consider Table 4, which compares rail, truckload, and LTL market shares, for a variety of commodities, with the importance of manufacturer's branches and wholesalers in the market channels for those commodities. There is substantial participation by distribution branches and wholesalers in both nondurable and durable markets.

Also note from Table 4 that rail market shares are highest for the

TABLE 3 Sectors of the Economy Which Derive Demand for General Freight Trucking, Inbound[a]

Sector		% of Market
Personal Consumption		27
Construction		12
Services		11
Government		7
Exports		4
Other		1
Manufacturing:		
Durables	21	
Nondurables	17	
Subtotal: Manufacturing	38	
TOTAL		100

[a] Based on input/output analysis, which ignores wholesale and other intermediate sectors. Therefore, freight inbound to wholesale and distribution establishments is attributed to the customers of those establishments.

SOURCE: IU International Management Corporation, 1978.

TABLE 4 Regulated Surface Freight Modal Shares for Selected Commodities

Commodity Description	Regulated Surface Freight Revenue	Mode Shares			Value[a]	% Branch Distribution[b]	% Wholesale[c]
		Rail	TL	LTL			
Nondurables							
Canned food	528,687	0.59	0.35	0.07	34.00	0.00	31.48
Books, magazines	253,481	0.05	0.24	0.70	110.00	3.23	0.21
Men's clothing	88,922	0.01	0.08	0.91	257.00	7.10	21.49
Women's clothing	16,404	0.03	0.16	0.81	296.00	12.68	25.22
Shoes	91,220	0.02	0.11	0.87	250.00	8.33	30.90
Drugs	80,200	0.13	0.42	0.46	1050.00	2.09	42.78
Tires and tubes	302,062	0.27	0.34	0.39	60.00	0.00	32.65
Durables							
Cutlery + hand tools	145,566	0.02	0.11	0.87	315.00	9.22	18.84
Plumbing + heating equipment	77,686	0.19	0.22	0.60	110.00	39.47	185.41
Construction + mining equipment	210,508	0.64	0.22	0.14	160.00	1.87	1.19
Material handling equipment	30,171	0.19	0.43	0.38	90.00	19.06	97.19
Engines + turbines	39,311	0.31	0.52	0.17	200.00	0.00	0.50
Metalworking machinery	50,218	0.13	0.19	0.68	280.00	4.60	18.17
Special industry machinery	46,860	0.14	0.41	0.45	300.00	3.15	13.95
Electric transmission equipment	110,553	0.14	0.19	0.67	200.00	45.55	171.01
Electric lighting + wiring	142,296	0.09	0.13	0.78	170.00	0.00	21.95
Appliances, radios, TV's	401,093	0.43	0.13	0.45	225.00	9.23	116.43
Motor vehicle parts	887,726	0.57	0.22	0.21	90.00	7.89	57.25
Optical equipment + lenses	2,522	0.01	0.24	0.75	800.00	0.00	92.20
Medical equipment + supplies	38,289	0.09	0.07	0.84	800.00	0.00	12.71
Opthalmic or opticion goods	1,748	0.00	0.11	0.89	1100.00	0.00	248.40
Photographic equipment	30,641	0.03	0.28	0.68	800.00	1.53	15.73

[a]Value = dollars per hundredweight.

[b]% Branch distribution = wholesale sales by manufacturer's branches + value of manufacturing shipments.

[c]% Wholesale = sales by merchant wholesalers + value of manufacturing shipments.

SOURCE: IU International Management Corporation, 1978.

commodities with the biggest volumes. (In fact, volume of freight moving was a much better explanatory variable for rail market share than value of commodity.) If the rails are rapidly losing their shares in these few big-volume manufactured commodities, as Dr. Herwald and Mr. Davis suggested this morning, the picture for rails is dismal indeed.

RELATIVE PRICE INCREASES: RAIL VS. TRUCKLOAD VS. LTL

There are three major possible causes for changes in the relationships between prices in the freight transport markets:

1. Impact of energy costs
2. Improvements in operations efficiency
3. Elimination of the cross-subsidization embedded in the freight rate structure.

A brief discussion of each is presented below:

1. Impact of Energy Costs.[1] The influence of fuel cost increases on freight transport mode splits is very unclear. As can be seen from Table 5, fuel expense per ton-mile in 1975 was substantially lower for rail than truck. However, fuel expenses were a much larger proportion of average price for rail. Therefore, as can be seen in Table 6, fuel price increases seem to have caused much more rapid increases in rail than in truck rates. In an unpublished paper, Dr. Wade German argues that much of the diversion of freight from rails to irregular-route truckload carriers in recent years can be attributed to such differences in freight rate increases.

Note carefully that while the rate of increase of rail rates has been higher than truck, this percentage increase is on a much smaller base, so the per hundredweight increase has been smaller for rail than for truck. That is, the difference between rail rates and truck rates per hundredweight has been growing, as shown in Table 7. Of course, other elements of total distribution costs (such as inventory carrying and handling costs) are higher with rail transport than with truck; and as can be seen in Table 7, other prices in the economy have risen much faster than the difference between truck and rail costs.

Since truck market share has continued to increase at the expense of rail during the period of rapid increases in energy prices, it seems safe to say that, in the short run at least, the increase in the difference in truck and rail prices has not diverted freight from truck to rail.

2. Improvements in Operations Efficiency. Prices in regulated trucking expecially LTL general freight, are based largely on the operating efficiency of the "average" truck line. In recent years, a large number of inefficient carriers have been "bled out" of the system by bankruptcies and acquisitions. Associated Transport and Eastern Express are examples of large, inefficient carriers that have gone bankrupt. Braswell, Western Gilette, and Navajo are examples of large, inefficient carriers that are being acquired by more efficient carriers. The trend

TABLE 5 Fuel Expense, by Mode

	RAIL[a]	TRUCK[b]		AIR[c]
	Class I Freight Service Only	All ICC Regulated, Class I and II	General Commodity, Class I & II Only	All Domestic Truck and Local Service Carriers
Fuel expense ($000)	1,101,100	889,823	535,329	2,031,307
Operating revenues ($000)	15,893,101	19,025,005	11,986,038	11,665,000
Ton-miles (millions)	754,580	175,135	86,078	N/A
Fuel expense (% of revenues)	6.93%	4.67%	4.46%	17.4%
Fuel expense per ton-mile	0.145¢	0.508¢	0.622¢	N/A

[a] Data from ICC, Transport Statistics, 1976. Expenses and revenues shown include all those allocated to freight service. Fuel expense does not include $10.166 million in train electricity allocated to freight service.

[b] Data from Trincs Blue Book of the Trucking Industry, 1975. Fuel cost figures include lubricating oil expense.

[c] Data on fuel cost from USDOT, Energy Statistics, data on total revenues from CAB, Handbook of Airline Statistics.

SOURCE: IU International Management Corporation, 1978.

TABLE 6 Fuel Price Increases vs. Carrier Freight Rates

	Petroleum Wholesale Price Index[a]	Class I Rail[b]	Class I and II Truck[c]		Scheduled Domestic Air[d]
			All ICC Regulated	General Commodity	
1972	100.0	100.0	100.0	100.0	100.0
1973	118.2	99.9	105.6	102.5	102.4
1974	205.1	114.5	109.8	110.5	113.9
1975	236.4	126.1	120.0	125.3	124.0
1976	254.0	135.6	123.3	129.0	139.8

[a] From USDOC, Business Statistics--1975 and Survey of Current Business, July, 1977.

[b] From AAR, Yearbook of Railroad Facts--1977.

[c] Revenue and ton-mile figures from Trinc's Blue Book of the Trucking Industry, 1973-77. Figures relate to intercity service only.

[d] From TAA's, Transportation Facts and Trends, 1977.

SOURCE: IU International Management Corporation, 1978.

TABLE 7 Rate of Increase in Difference Between Truck and Rail Rates vs. Increase in General Price Index

	Wholesale Price Index	Truck-Rail Difference
1972	100.0	100.0
1973	113.1	107.0
1974	134.4	108.8
1975	146.8	118.5
1976	153.6	120.3

SOURCES: Same as previous tables. Truck average revenue per hundredweight based on all ICC-regulated Class I and II carriers. IU International Management Corporation, 1978.

is toward an industry dominated by big efficient carriers that will eventually force system average costs, and prices, down. However, in the short run, for every "also ran" that goes bankrupt or is acquired, there are two more that go from average to marginal. Competitive pressures from the most efficient carriers are becoming fierce, and only strong carriers will survive in the long run. During the period of shake-out, however, average efficiency may get worse before it gets better, which would put upward pressure in the short run on relative prices of general freight trucking.

There is some question concerning whether long-run efficiency improvements can overcome the growing cost differential between Teamster and nonunion labor. The growth of private trucking, irregular route carriers, and owner-operators are all related in large part to the cost of union labor. The sluggishness of LTL growth is attributable in part to the fact that many shippers are increasingly finding capital intensive integrated distribution systems preferable to Teamster labor-intensive LTL trucking. The attitudes of the Teamsters in the 1979 contract negotiations will have a substantial influence on general freight trucking growth into the 1980's.

3. Elimination of Cross-Subsidies. The sluggishness of LTL growth, especially in the 2,000-10,000-pound shipment size categories is largely attributable to profit margins in those sectors that often run as high as 30 percent. High prices reflecting such excess profits are deemed necessary to offset losses in other segments, in which political pressures have kept prices below compensatory levels. If the industry is successful in redesigning the rate structure, our forecast of LTL stagnancy may happily prove to be overly conservative.

PRICE ELASTICITY OF DEMAND

It is widely believed in the trucking industry that demand for LTL service is relatively price inelastic. The proponents of this thesis believe (a) that there are no practical alternatives for many of the shipments and shippers using this service, and (b) that quality of service is much more important than price in this segment of the market.

It probably is true that availability and quality of service are much more important than price as determinants of demand for LTL, in the short run. The most effective substitutes for LTL require investments and/or system redesign: aggregation to truckload-size shipments (which requires storage and related PD costs), investment in a private fleet, designing pricing strategies to convince customers to take larger shipments, building warehouses, and, in the extreme, investment in rail sidings. The cost of the components of many of these alternatives has increased faster in recent years than LTL rates (warehouse construction costs and capital costs for inventory investments, for example).

However, the fact that availability and quality of service are more important than LTL price is a double-edged sword. The quality of service from well-designed PD systems can be substantially better than LTL trucking; and once a shipper has taken the step to develop integrated PD

systems, availability is the enemy, not ally, of LTL trucking.

In sum, I argue that demand for LTL trucking is price inelastic in the short run, price elastic over the relatively long run, and that the LTL growth problem we are now facing is the lagged effect of many years of bad pricing practices.

Similarly, redesign of industry pricing practices is not likely to immediately stimulate LTL growth, but is a necessity for the long-term growth and financial health of the general freight industry.

CONCLUDING REMARKS

Time does not allow a thorough discussion of the factors of demand for trucking services. For example, the growing difference in the quality of service by rail and truck, which was prominently mentioned in papers presented this morning, was ignored in this paper. However, this paper has underscored the importance of understanding the assumptions, explicit and implicit, embedded in long-range forecasts of freight transport demand for individual modes. It seems clear that much of our future research must be concentrated on better understanding these assumptions.

NOTES

1. This section is taken from an IU International internal memorandum by Ralph Samuelson with the author's permission.

DISCUSSION

MR. SOORIKIAN: You have done an excellent job here, but I would like to see the rest of it. In other words, what is really missing is the scale economies involved in manufacturing, the impact of the service on levels of inventory, and also you have some very interesting ratios in terms of the modal shares. I would like to see that really related to value of product, because that is partly the explanation. Have you done anything in that particular area?

DR. LAWRENCE: Value of product is one of the variables that is listed in that exhibit. I didn't talk about it, because I could have gone on all day about that single exhibit (Table 4, page 131). The third column from the right is value of product, and, although it is dangerous to base a statistical analysis on a sample of 22 commodities, we have analyzed those 22 commodities in every possible fashion. We found that value of commodity was marginally related to the modal shares. The highest correlation coefficient between value and any of these modal shares was around 40 percent, which means that in effect about 16 percent of the differences in modal shares was explained by the value of the commodity. The single most important explanatory variable that we

found for rail shares was the amount of freight being moved. The very largest industries, regardless of the value of commodity, generally had relatively high rail mode shares.

I happen to agree with you, and certainly the classical physical distribution theory would agree, that value of commodity is the single most important determinant of LTL share; but we still haven't been able to find that relationship statistically. That doesn't mean it doesn't exist. Did that answer your question?

MR. SOORIKIAN: To a certain extent, but I would like to follow it with, perhaps, another question. The point I am trying to make, and the question I have is that the totality of the picture involves much more than the transportation problem we have been trying to solve here. It really involves the distribution center concepts that we have touched on. Your analysis is very cogent concerning the impact it has on LTL traffic. But, assuming we are here to suggest some solutions to the problem, then these redistribution concepts, the reordering, perhaps, within the national economy and international economy, that is, the points that will yield the most efficient transportation system should be a major consideration. We should look at it from the standpoint not only of the transportation system as it exists, but what it should be.

It perhaps suggests reordering distribution centers that have come to be accepted only because they exist, that is, only because they are major terminal points for carriers. But that system serves, in the case of trucking at least, an existing LTL structure. That LTL structure has a lot of fat in it. And I think the purpose in relating to the overall activity in terms of the most efficient system is that we must continue to consider what these other points are and how to get there.

DR. LAWRENCE: I will respond to two aspects of it. One of them is that maybe we should try to hire you away from ITT and have you come show us where all that fat is, because we try hard every day to get it out.

The second one is that I agree with you if you are saying that the national research effort in freight transportation has ignored the question of what is the most efficient possible way to combine the components of the total distribution concept so that our national distribution system is, in effect, more efficient. Certainly, individual companies such as ITT and Johnson & Johnson are performing "frontier-of-human-knowledge" efforts in reducing their own total distribution costs. I am not sure that the total national transportation distribution costs will be minimized as the result of every individual company, especially every individual large company, minimizing their own total distribution costs.

MR. WARING: You made one statement that puzzled me a bit. You explained how the average rate-making process tends to cull out the least efficient carriers, and then you made the statement, if I understood you correctly, that, "in the near term, we might experience a loss of efficiency in the industry." Did I understand you correctly and, if so, would you elaborate?

DR. LAWRENCE: I knew that I was going to create a problem with my trucking brethren in the room, and I said that advisedly. I am not sure

that I am right, but the line of reasoning goes this way: The reason that the incidence of bankruptcies in general freight trucking is increasing at a rapid rate is that the very big carriers are gaining market share at a rapid rate. That market share is coming out of the hide of other general freight trucking companies, and many of them can't stand the heat. The process by which we are creating inefficiencies for other truck lines is the process that in the long run will make the trucking industry more efficient because the most efficient carriers will move the freight.

The thing that I don't know is, what the rate is by which the companies are going bankrupt and being bled out of the industry and what the rate is at which other truck lines are deteriorating. If the rate of deterioration in inefficient truck lines that continue to exist is faster than the rate by which other inefficient companies are going bankrupt and being acquired, then the average system cost is increasing. It may be that the deterioration is not as fast as the bleeding rate. But it may be, and if it is, then there is going to be some pressure, especially on LTL prices, in the next 2 to 5 years.

MR. McNERGNEY: I have two questions. One, how much do you attribute the decline of LTL in comparison to your economic indices to this hesitancy to serve that particular market as you alluded to? Is that a significant factor, or was that just a side remark in terms of really what the motor carriers have promoted and attempted to generate in that market?

DR. LAWRENCE: The simple answer is, I don't know. The more complicated answer is, while it is true that there is freight that we like to handle better than other types of freight, certainly the general freight companies that we operate, Ryder and PIE, honor our common carrier responsibility, and therefore we handle the freight that is tendered to us. So the question of how the LTL growth rate is being affected by our preference not to handle certain types of freight really depends upon the sensitivity of the demand for trucking services in that segment of the market to our sales solicitation efforts. The only way that we handle that freight any differently is in the fact that we don't go asking people to give us freight we don't want. If that segment of the market is sensitive to the absence of a sales solicitation effort, then the sluggishness of LTL growth is proportionately attributable to the absence of solicitation. I don't know how sensitive it is. I suspect it is somewhat; I also suspect it is less than you might think it is.

MR. McNERGNEY: My question is in reference to the totality of the physical distribution and distribution center concept in that your analysis and any modeling effort doesn't take the total picture into view. It is a very difficult and a very complex one, I know, to layout and to model. Every time we seem to approach the issue of efficiencies we get buried in the maze of regulatory problems and other superficial constraints. Aren't we ignoring the best indicator, which is still the free market force? Haven't you seen traffic distributed in that particular sense as large corporations have established either their own service through private trucking, their own distribution centers, or there have been modal shifts in accordance with the competitive advan-

tages? So you come right back to competitive market forces in the end result to get around some of the regulatory constraints you have to resist.

DR. LAWRENCE: I have a 112-page book that I am going to mail to you as the answer to that question, and I am not being facetious. That is an enormously complicated question, but to give a brief answer, the economic objective of minimizing total transportation costs to individual sectors of the economy historically has not been the objective of national transportation policy. There are sociopolitical objectives involved; there are equity questions involved. And even if we decide at this late date to redesign national transportation policy so that technical economic efficiency is the only objective of national transportation policy, we are going to find enormous dislocations and disruptions caused in society and in the economy because our regional economic patterns and many other economic decisions that have been greatly influenced by this quiltwork of transportation policy and regulation that has been developed over the last 90-some odd years.

And so maybe you are right in the long run. Maybe free market forces ought to be allowed to work, but how we get from here to there is something that is going to take someone smarter than I to figure out.

PANEL REPORTS

TRANSPORTATION DEMAND AND RESEARCH NEEDS

INTRODUCTION

Donald S. Berry
Walter P. Murphy Professor
of Civil Engineering
Northwestern University

It might be well for me to read what Dr. Nelson has written as the charge for the panels. The charge relating to the major commodities that are to be the areas of concern for each panel are:

1. What are the major factors that you believe will affect the trends of freight movement demand over the next 10 to 20 years? If possible, estimate them. To what degree do you think the major commodity demand may be affected, considering, of course, that there are different levels of detail as to commodities, modes, geographic areas, etc.?
2. What types of data on commodity movements do you view as a critical need, and what research or analysis efforts do you believe would be valuable in contributing to improvement in the process of forecasting the needs for movement of the various commodities?

AGGREGATE DEMAND AND RESEARCH NEEDS

Paul O. Roberts
Professor of Transportation
Massachusetts Institute of Technology

Our panel addressed the subjects of aggregate, that is, overall demand of forecasting, and of the related research needs. We quickly learned that there are many different users for any data we might acquire and that all the users have different needs. It is, therefore, not practical to specify precisely what is needed at this time, or to be completely definitive about what has to be collected. Nevertheless, we did develop a number of useful ideas. Several of these can be explained more easily with charts that I brought with me. I will discuss those later.

In considering research needs, the first concern was data--data that can be used to make forecasts of the future under different policy options. We agreed that the data we want and need does not now exist. There are some models built on inadequate data, and some forecasts that I believe all would agree could be improved. But, a comprehensive freight data base for the United States is just not available. That was a surprise to most.

The next concern addressed was, "What data do we need and why do we need it?" That is, "What is the objective to be accomplished with the data that we want?" The data might be used directly for what it can tell us, or used indirectly, to help build the models to be used in forecasting. Altogether we were able to identify some five different uses for the data. These were:

1. Public Policy Analysis. The data could be used directly to improve decisions affecting the public, or the data might simply be provided to permit more meaningful public debates to take place (i.e., If the public doesn't know what is going on now, how can there be a sensible argument about needs?)
2. Infrastructure Planning. For such planning, one needs certain kinds of data, flows, capacity, and other information for use in the design process.
3. Regulatory Management. Information is required for management of the regulatory system. As previously noted, this function is just a specialized area of public policy, but it may be a little different and will be listed separately.
4. Carrier Management. Carriers need data if they are to manage their organizations effectively. Their needs are very diverse, but

they are quite different from public policy needs.

5. Other Information. Finally, others, such as the equipment manufacturers, need information. Their requirements are typically for more aggregate information, (e.g., total ton-miles by mode).

It is difficult to produce one set of data that will satisfy each of these identified uses. At least, we have not been able to do so to date.

The requirement for diversity in data needs led to consideration of the more general question of aggregate versus disaggregate data. We have just listened to a description of the Wharton Model, which as you know, is a national forecast. The authors said that one of the things they regretted was that better data was not abailable so that regional forecasts could be done as well. Others added, "Well, county forecasts could also be useful. We are interested in a more detailed look." Still others were interested in point-to-point flows of a particular commodity, even link-by-link flows. In infrastructure planning, obviously, a link-by-link capability is important. Similarly, the development of accurate modal revenue estimates would depend on the availability of substantial detail in network structure.

The question was raised as to whether we were interested in data in a spatially disaggregated sense or in a time disaggregated sense. Some were anxious to know what the changes would be over the next 6 months. Others were interested in whether longer-term change was going to occur in the South or the West, or whether it was going to occur on this link or that link. We noted these differences as well.

There was discussion about the specifics needed in detail forecasts. Of course, all wanted commodity detail. Fairly modest commodity detail requests emerged first, but it soon became apparent that many users of data wanted very specific commodity detail, while others would be satisfied with greater aggregations of commodity detail.

John Terry mentioned that he would like to see more submodal detail--detail that permits a close view of the modal system including product differentiation within the modes.

John Kuypers, our representative from the national defense establishment, expressed need for information on bridge loadings, curvature, and related questions. We could see that the range of data identified as "needed," not only on commodity movements, but also concerning attributes of the system itself and its infrastructure, was certainly expanding.

Finally, the question of capital and capital needs was addressed. My personal feeling by that time was that the problem was almost out of hand. On one side, we want a picture of the whole world in all of its detail, yet, on the other side, the individuals who want the information need statistics summarizing their very detailed data. There is a need to look at data in aggregated forms, because most decisions are made on aggregate pieces of information, not disaggregate pieces of information.

I believe it might be useful to show you the charts I referred to, to help develop a few definitions and to illustrate possible applications of the knowledge that can come from increased understanding. Later

I will summarize our views concerning modeling and the other areas considered.

Figure 1 deals with the question of aggregate versus disaggregate measures, and it seems to me that is a very fundamental issue for this conference. Simply stated, most decisions must be taken on aggregate pieces of information. A disaggregate observation, for example, the fact that a shipment went from St. Louis to Kansas City, has almost no meaning in itself. The fact that 100,000 of these shipments take place every day is the important fact that the carrier manager, for example, uses in his decision-making process. Figure 1 identifies several examples in each of the categories.

There is always an original survey consisting of disaggregate observations. With a particular question in mind, it is frequently possible to produce a more aggregate summary from that series of observations that is then useful in any kind of decision-making, (e.g., 30 percent of the shipments went by truck).

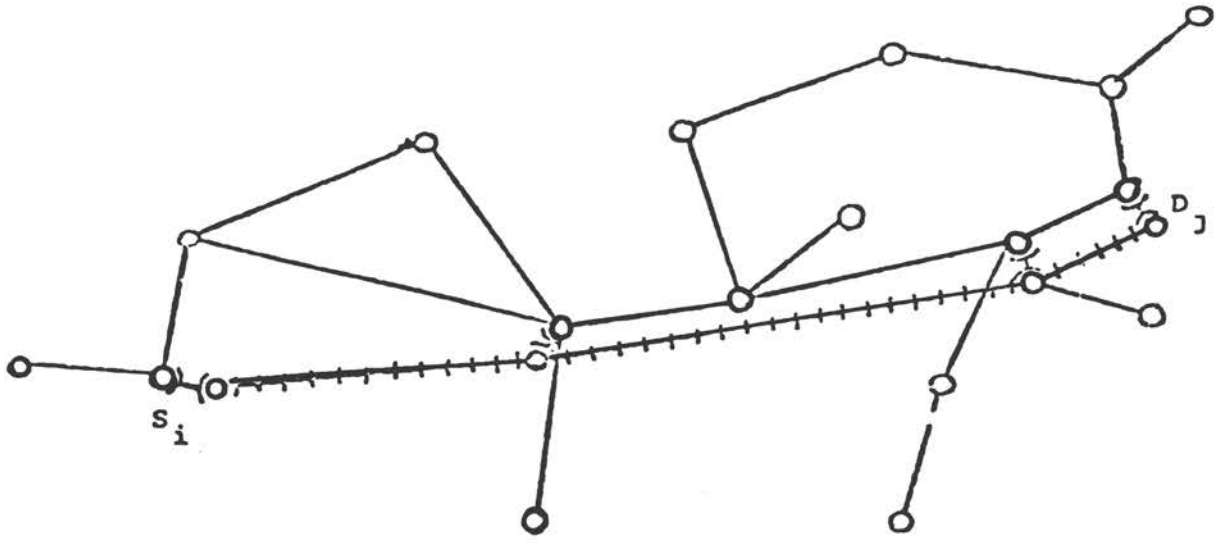
AGGREGATE MEASURES	DISAGGREGATE MEASURES
TONS	V^K_{ijgm}
TON MILES	
REVENUES	ORIGIN TO DESTINATION TONS BY COMMODITY, FOR EACH
VEHICLE MILES	MODE AND SHIPMENT SIZE

FIGURE 1 Aggregate vs. disaggregate measures.

Figure 2 relates to the subject of temporal demands. We observed some examples yesterday in the Wharton Model. The aggregate measures of principal interest were the temporal changes, that is the changes over time. But, we are also interested in summaries over time, information that represents flows of a particular commodity for a given period between a supply point "i", and a destination point "j". That summary gives the volume of the goods that travels between those points. This is an aggregate piece of information concerning commodity flow that is frequently of interest.

Note that the flow occurs over a very detailed network in the real world, and aspects of the choice of mode and the routing over that network may be important in the final analysis. This represents a further subdisaggregation of the origin to destination flow, V_{ij}, shown as an element in the matrix.

The basic unit of information reporting freight commodity movements involves a shipment. Figure 3 shows patterns of shipment flows. Ship-



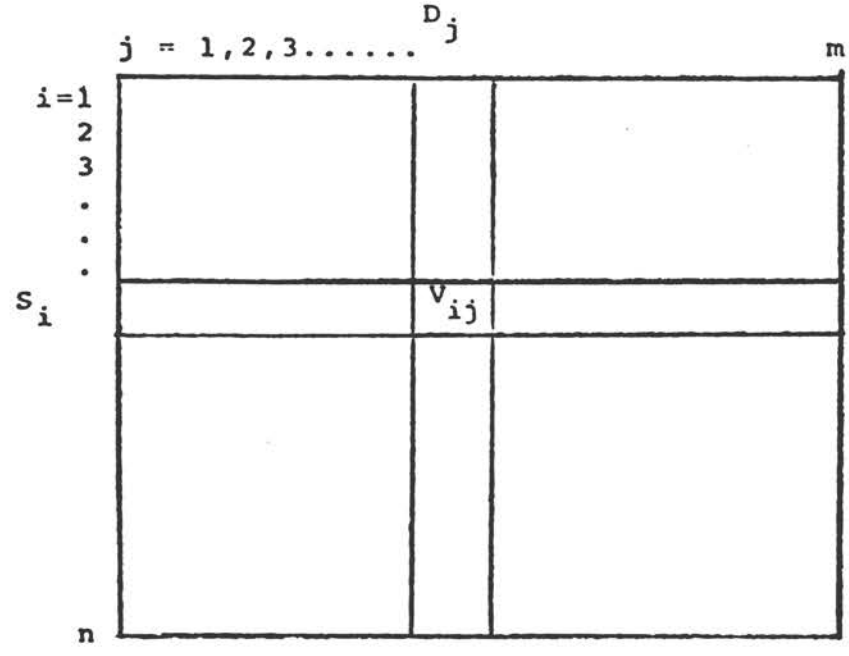
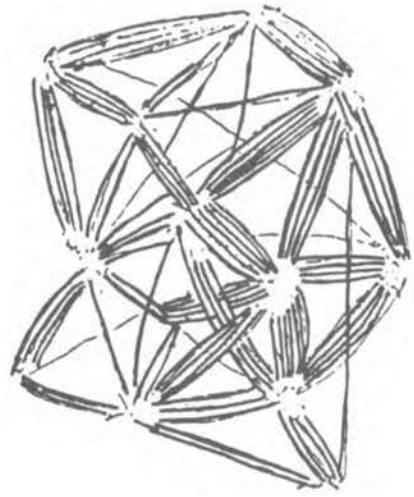
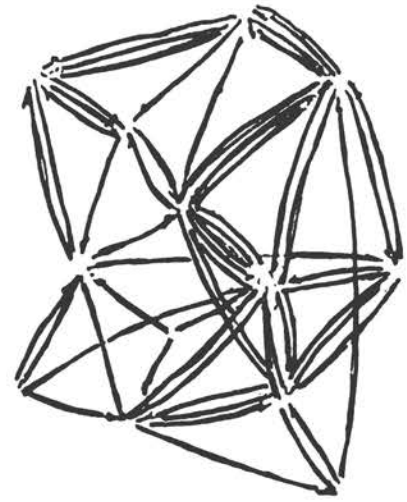


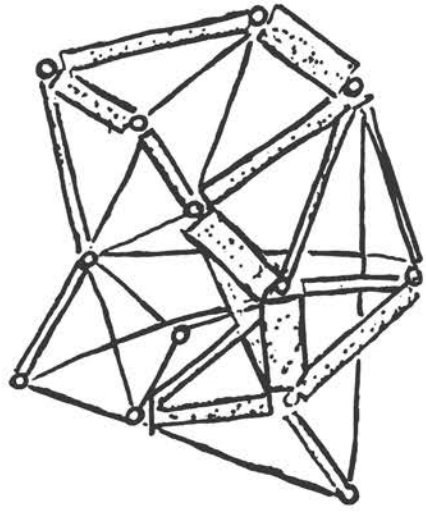
FIGURE 2 Representation of the transport network and matrix showing origin to destination transport flows.



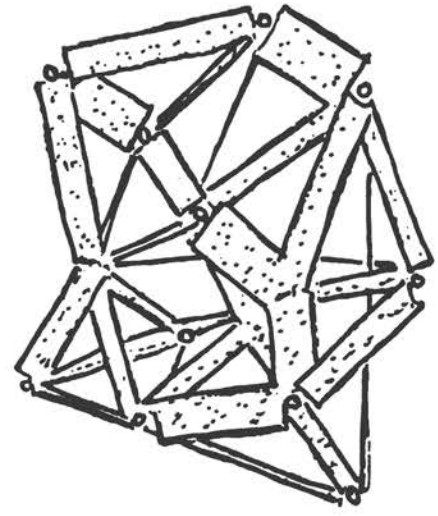
SHIPMENTS IN THE
REAL WORLD



REPRESENTATIVE SAMPLES
OF THESE SHIPMENTS



AGGREGATED ESTIMATES
OF TOTAL FLOWS



FORECASTS OF
FUTURE FLOWS

FIGURE 3 Four types of shipment information.

ments are observed moving in the real world. By drawing up a representative sample of these shipments, they can be studied in more detail. A sample of shipments can then be aggregated to get a picture of the total flows. As we aggregate, we are throwing information away. As we throw the information away, it is no longer available for anybody to use. For example, if the aggregation was performed without regard to commodity, this information is lost. The dilemma posed by the situation is that on the one hand, we need aggregated summary information on which to make our decisions. On the other hand, as we aggregate, we throw information away. Invariably, one person's aggregate flow picture is not what somebody else needs. They may need a totally different aggregation.

Finally, if we take these aggregated estimates of total flows and use either trend extrapolation or a model, or even if we only use someone's best guess, we arrive at forecasts of future flows. That is what we are showing in the diagram at the lower right in Figure 3.

There is nothing that I have presented here that most of us don't already know, but I do believe that there are some important lessons to be learned. I am most impressed by the fact that, once one has performed the aggregation needed to make policy decisions, much information has been lost. If the information could be retained at the level of the individual observations in the sample, then one could aggregate it any way desired to answer a wide range of policy questions that were considered important. Reaggregation is a difficult process, but it is something that is worth doing on occasion.

The people at the ICC, Ernie Olson's office, have recently conducted an "Empty-Loaded Survey" of truck traffic. I think they are to be commended on that survey because it was a disaggregate sampling of truck flows. It was carefully done statistically, and when it was finished it was coded and put in the computer. They have left it in disaggregate form in the computer, so that one can ask questions that cause the data to be reaggregated in any way desired, to get the kind of answers needed to address a particular problem.

This particular disaggregate data set doesn't solve every problem. It only solves the problems that have to do with the data that was gathered and placed in the computer in the first place. Because the sampling frame is known for this data, and because those on the project know just exactly how to recombine the data that is in the computer, it is most useful as an on-line data base.

However, it is so easy to lose the all-important information describing the sampling frame or the stratified sampling plan. The individual observations may contain coding errors or the entire questionnaire may not have been coded. The sample may be so large that it is difficult to work with. There are many reasons why the original sample may be thrown away once the original information needs have been met.

We need and can use that kind of computerized disaggregate data base that the ICC has developed for truck flows to address any number of other problems. I think that, in our larger data collection efforts, we ought to be working toward defining and developing a coordinated set of disaggregate data bases.

As it stands right now, the few disaggregate data bases that we

have for commodity flows are very unrepresentative. There are other problems with which many of you are already familiar. The Census of Transportation, the most well-known of these disaggregate data bases, covers only a portion of the whole economy, namely, just the manufacturing portion. But there is a problem. It is a secret data base, that is, you can never get at the disaggregate portion of it because it is in the Census Bureau under lock and key. There are, of course, reasons for that, but it would not have to be the case. Other data in the public domain is left for people to use in official studies. It would take some creative effort to design a suitable replacement that was not secret, but I think it would be well worth it. The Census of Transportation also has statistical problems caused by lack of completeness, but that is more than we want to get into at this point.

Let me summarize by saying that I thought that one series of interchanges in our discussion was particularly apt. Ernie Olson said that this data base that we were talking about, the "Empty-Loaded Survey," was in fact a "hmm" data base. The "hmm" was a "we don't know exactly what it is we want, hmm," or a "let's take a sample and see if we can find something out, hmm."

It is to be hoped that when one has examined the data base, if it is a good one, it turns out to be an "ah ha" data base. That is, you found out something from looking at it. Damian Kulash volunteered that, in fact, most of the data bases that we gather are more likely to be "ho hum" data bases, because they just sit there; we know exactly what is in them and they don't give us any new information. And since in most cases they are presented in aggregate form, we can't recombine them any other way than they are presently aggregated. I believe we ought to be working to get more of the "hmm" and "ah ha" data bases, so we can retire the "ho hum" type.

DISCUSSION

DR. MARGOLIN: In the full sessions, i.e., plenary sessions, and in some of the committee or panel sessions, we seemed to pay most of our attention to rail and truck. We did touch on slurry pipelines, and to some degree on the movement of energy commodities, including petroleum and a few others.

But it is my impression that we didn't pay enough attention to air cargo movement in the future, even though the volume may not be great. Compared to the total volume, it is infinitesimal. Secondly, we didn't give enough attention to the future for pipeline movements, including solids as well as natural gas. I offer these comments, although what you summarized tended to cover pretty much all of the different modal movements.

In the same vein, while we discussed it from time to time, including piggyback freight, and so on, I don't think we paid enough attention to intermodal movements. I suppose I could even make the same type of

comment that would apply to a lesser degree, even though there was a bit of discussion the first day, concerning waterway transportation and the different components of the waterway movement. And last, for the overall committee work that you are doing, are you supposed to include the international movements as well, and international demand? Is that incorporated, or are you confined pretty much to domestic?

DR. ROBERTS: I don't know the answer to that question, but from my point of view as an individual, it is true that you need information on international movements if you are to deal with commodities adequately.

DR. BERRY: The focus of the study was on the freight movement in the United States, but the interface with international movements was considered.

MR. WARD: I would like to suggest that a research need that we frequently overlook is to look at how major changes in the supply characteristics of the transportation system, that is, the performance capabilities that we can get out of the system, could change the demand for the system. We tend to examine what will happen to demand in the light of all kinds of exogenous events, except changing the transportation system. I think that neglect is important and that it is important to fill that void.

DR. ROBERTS: I must say that our demand estimates have been so inadequate, that we hope you will forgive us if we get overexcited about a new-found ability to manipulate the system to see how demand changes. For years and years everyone just assumed that all the flows would stay exactly the same. In fact, we have worked on that assumption so long that we have forgotten how it feels to deal with systems that are "soft and squishy."

But I also agree with you, Jerry, that being able to manipulate the supply side to see how it impacts the demand side would be extremely useful.

MR. JOHNSON: With reference to the last few comments, I have been observing what you have been doing, because I know you have a lot of problems, in rail primarily, in the relatively near term. NASA's interest is in our air cargo, and furthermore, by the nature of our involvement--we don't build airplanes or operate them or ship anything--as Jim Gorham pointed out, we are looking 10 to 20 years out ahead. But to return to the question that Jerry just mentioned; that if a better transportation system is to be evolved to the good of the operators and the consumers and the national economy, some people are interested in projecting out beyond the next 5 years or so. This is a small interest compared to the big one that you have been dealing with in the last couple of years.

But it does indicate that there are some needs that in a gross sense--and again, I agree that you don't worry about the last 5 percent--are really things that can be done for transportation over and above meeting the needs of the demand that you have been working on. In this sense, whether it is the government or whether it is General Motors or another company like that producing equipment, or whether it is the FAA or the ICC or an official who is regulating and needs to know more about what is possible, there are certain research needs in the way of

demand forecasting in a gross sense. Things that will allow corporate planners, or government planners, the OMB, or the Congress, to say "Yes, it is worth a certain amount of long lead time, development, and research to get that better transportation system," will ultimately have a fundamental impact on the total distribution of goods, and the strength of the U.S. economy.

Filling such a need requires an access to data, but not lots and lots of detailed data. And it is a combination of trend data, working with what you have, to a sampling of "what would happen if." As an example, last week we heard a report on a couple of our fairly large contracts that were to look at the future of the air cargo system. We found a very fundamental debate between the two contractors. One said to a lot of shippers and consignees and operators, "What would happen if you could reduce the cost of air transportation by, say, 40 percent, and provide a lot of intermodal compatibility, containers, and other aspects of interfacing with, primarily, trucks?" They took the resulting data and said, "Okay, let's suppose this is real." They processed it in a methodical way into a demand forecast, say to the year 1990.

The other set of contractors said, "This kind of thing is almost foolish. There is just no validity in asking somebody what they would do. The only thing that is valid is what they have done." And so they looked at the qualitative aspects of what could be learned by asking people what they see in the future, based on what these people perceived in the past.

I am not going to judge who had the right answers. Probably a combination of the two. We can't fool ourselves by saying that data that we could collect on supposition is real, but some approach needs to be taken for the purpose of those who are interested in the long-term development of transportation systems in order to get at least a gross estimate of elasticities, of shifts in distribution systems in response to better capability.

I don't know what that leads to in the way of data, but there is a need for something that guides the longer-term development so that we can ultimately lead to much better transportation systems.

DR. ROBERTS: I agree with you, that if we can build a better causal understanding of how people make their freight movement decisions, then one ought to be able to say what would happen if an air freighter could be obtained at half the cost, that had twice the speed, and so on. One then ought to be able to see what market share it would attract.

On the other side of the coin you have to recognize that the improved understanding tells us that this new airplane is going to steal a lot of somebody's traffic. The losers may be very upset. Even if it is future traffic, the losing group may try to get it voted out of Congress.

DR. BERRY: I might comment on the intermodal problem, which you all brought up, that we haven't covered, perhaps, very adequately today. I think we have some people in the audience here that are familiar with some of the work that DOT has done in that area. I would appreciate a brief comment on just what has been going on, on what kinds of reports are coming out, on the intermodal model, and the setting up of the systems for piggyback terminals.

DR. CHU: I can say a little bit with respect to what has been going on. Most are aware that the FRA has had an intermodal feasibility study done that was completed a couple of years ago. It was an economic, as well as a systems-type of paper study. And as Alan Butchman indicated yesterday, the first leg of the service demonstration program began a week ago Monday, on a segment between Chicago and the Twin Cities.

In conjunction with that service demonstration program, the FRA's R&D organization has initiated a two phased systems engineering study related to various aspects of freight intermodal technology. Phase I was designed to take a look at the current state of the art of the various intermodal technologies--with a view toward identifying those that appear to be reasonably feasible. In Phase II there will be a more detailed look at the most promising of the technologies identified.

Separate from that, there is an effort at the Transportation Systems Center on advanced freight transportation systems. That is under Larry Greene, and the purpose is to take a look further into the future at some of the intrinsic properties of freight transportation. They will attempt to look at that and hope to derive areas where there may be opportunities for technical improvement.

As is the FRA study, the TSC Phase I study is complete, and the Phase II effort is now going on.

I might also add in line with the comments that were just made by Paul Johnson and Jerry Ward in terms of demand, that some changes are not necessarily detectable by projecting current trends. Some of the things that we would like to know are: When will a continuation of present trends no longer suffice? When will more of the same, building more track or laying on more concrete just not be sufficient? We would like to know in the future when there will be a convergence of factors at work--whether it is because of graphic shifts, or because of spatial changes, or other factors--that will introduce a discontinuity in the supply system? To use Bill Duffy's or Bill Garrison's words, When will there be a new dynamic in our system?

DURABLE GOODS DEMAND

William R. Blair
Outbound Traffic Manager
Caterpillar Tractor Company

During our discussions we developed a new identification of the data base. To go with panel reports' "Hmm," and "Ho Hum" categories of data, we had one that was called "Wow." Our group was very active and was most effective. I should mention that my participation in this workshop is my first in the committee's freight system study. Out in the middle of Illinois we thought we might be alone in worrying about and being concerned about transportation in the future, so I was most impressed to find all the activity and the ideas passing back and forth at this meeting. I was also impressed at the way the meeting is organized. This action convinces me that the transportation will be available that is needed to distribute the durable goods or the raw materials the country requires and that there will be in the future an outstanding transportation system.

The Durable Goods Panel offers the following key factors for consideration. We felt it would be useful to identify the objective we are trying to achieve in a form of preamble, stated this way: "In order to ensure the availability of a viable transportation distribution system in the period 1995 to 2000, and to provide an ongoing system prior to that period, certain valid planning and projections are required. The results will provide the guide necessary to structure and expand the physical facilities of rail, highway, air, and water. The resulting validated projections will further assist in better understanding and preplanning the specific area needs for rail, new and improved right-of-ways, extension, and the repair of the interstate, primary, and secondary highway systems, airport expansion and waterway improvements."

We then considered the first of the two major questions posed by the chairman of the workshop to the participants: What are the major factors affecting demand? We divided that into three categories: first, demographics; second, transportation distribution system characteristics; and third, resource limitations and allocations. Under demographics, we identified as important the trend and the movement of the industry, the availability of skilled labor force, geographic location of consumer of durable goods, national income, the distribution of national income, household formation, age and distribution of the population. As important among transportation distribution characteristics, we first cited transportation availability and capability, with each of these related to rail, highway, water, and air facilities. Other characteristics

identified were: the degree and type of regulation that is applied to transportation, that is, the requirement for a regulatory structure appropriate to modern distribution needs; the total national distribution concept; the direct cost of the transportation and overall related distribution costs; the specific identification of key durable goods; the question of specialization versus decentralization; the idea of a classification system by area; and the identification of service-sensitive commodities and the interrelation with the previously mentioned transportation-related costs.

Under resource limitations and allocation, we identified as pertinent factors the availability of skilled labor force, the sources for and availability of capital, product availability in terms of relative cost, raw material availability, and finally energy availability dealing with volume need and the type of energy needed. With respect to source and availability of capital, we noted that in transportation providing capital may be a government responsibility, a private sector responsibility, or it may be a responsibility of both government and the private sector.

The second question posed by the workshop chairman relates to the type of data on commodity movement that is needed and what research and analysis efforts may be needed to improve forecasting. We summarized the overall needs as including a redesigned national survey to provide complete coverage by a statistically valid sample, including each major stage in the manufacturing and the physical distribution process. We identified several key points that we believed should be considered. First, the origin-destination, identified by zip code or any other valid location identifier; second, the type of establishment, whether it be source of raw material, manufacturer, warehouse, wholesaler, retailer, or any other; third, commodity classification; fourth, mode identification and equipment requirements; and fifth, shipment characteristic, that is, size, the weight and the handling requirements, whether the goods are perishable or not, and the packaging required.

In summarizing these points, we again reviewed all factors so far considered. While we recognize that in the short period available it is not possible to reach a full agreement, I have touched on the major items that our group considered for further consideration by all participants.

DISCUSSION

MS. BATTS: I would like to ask you the same question I asked our group, which was the group that considered the total overall demands for forecasting. Who is going to pay for such a program? Is it the shipper's responsibility to collate and supply that kind of data? Is it the transportation company's responsibility? Does government somehow subsidize us? Who is going to pay?

MR. BLAIR: I will make some general comments, and then I would appreciate any specific comments from the members of the panel. The total overall freight transportation and distribution bill, as previously mentioned, is upward of $150 billion. There are certain census data taken today on manufacturers and on transportation surveys that I believe--and I add we did not consider this factor in any great detail because we were not familiar with all the details available--could bring together all the factors, whether they be in the carrier field, the manufacturer field, or the wholesaler field. Such information is being produced and furnished now to many government agencies. If this information can be identified and brought together, I think that without additional cost the information really needed could be made available.

Now, I would like to solicit comments from our panel members.

DR. HERWALD: Paul Roberts mentioned that such data can be made statistically valid, too, and that one doesn't need to go to the last corner for the million dollar bit of data that is missing. It can be done on a pretty broad sample basis, and can still provide somewhere around 95 percent accuracy.

MR. BLAIR: Our panel members felt strongly, and I do, too, that a combination of all the available statistics now, properly used, would probably provide us the information this is necessary and required to project what needs to be done through the year 2000. Further, we thought this might be done without any additional cost, and perhaps with even less cost.

NONDURABLE GOODS DEMAND

James P. Romualdi
Director, Transportation Research Institute
Carnegie-Mellon University

Our panel on nondurable goods is a small one, and I can tell you who was on it, because if there are any questions I am going to depend upon them: Ed Margolin of the National Transportation Policy Study Commission; Bob McNergney of SRI; Byron Nupp of the Department of Transportation; Bill Smith of General Mills; and we were joined today by Ray Glembocki of the Air Transport Association. It is a very good group. We had a good mix, and a very active session.

We tried to address the two questions posed, and got into trouble immediately. The problem started with trying to decide why certain products were classified as nondurable and some were not. We believe, however, that our attempts to untangle this issue led us to some of our more interesting conclusions and recommendations.

We started off with a list that was included in the paper given by Michael Lawrence. He had listed some nondurables and durables. Under nondurables were drugs, tires and tubes, men's clothing, and canned food. And under durables were things like photographic equipment, optical goods, medical equipment and supplies, and, of course, construction and mining equipment.

We kept going through the list trying to find out if it was value per hundredweight or some other characteristic that distinguished durable and nondurable. We looked at the list of nondurable that was given our panel as background, and that included some 49 commodities. It included wholesale and retail trade, drugs and paints, but not all rubber products. We didn't have instruments and we didn't have textiles, but the list included clothing. I was getting very confused, but I wasn't too concerned at first, because, I said, well, I am an engineer and these are issues that were solved long ago, I am sure, by economists. And so, in wide-eyed innocence, yesterday and today I got in touch with several economists--there is a reasonably good supply here--and I asked this question, "Will you please put me straight on what is the definition of durable and nondurable goods?" I assumed it was something I had not seen.

And I got nothing but confusion back. In fact, when I asked several people and took the sum of all of these opinions, I ended up with a vector of zero length.

Now, I don't want to be cute and funny about it. This turned out to be worthwhile on our part, because then we got together and decided

that we would try to come up with a generic definition that would, in turn, have some direct link to issues of cost of transport and distribution, the need for warehousing, the response to growth in communication technology, and things of that sort. We would try to come up with a generic definition and get away from this trying to put specific items in specific boxes.

We hope the value of doing this will become a little clearer later on in my summary remarks.

So we adopted the following definition: "A nondurable good," which could, I should indicate, include certain agricultural products as well as manufactured, "is (a) a consumer item that has as its purpose the satisfaction of some need for the last purchaser. Also, it is usually expected to be available on demand." I say "usually"--it doesn't apply to all of these. "Usually expected to be available on demand, and therefore must be stocked or shelved at the last point of the distribution cycle before it is consumed; (b) it has certain special distribution characteristics in that it moves through warehousing distribution outlets and retail facilities in a fairly complex manner, and as such inevitably at some point in its passage from the origin source to the final user, at least for some part of that trip, it moves by truck; and (c) it has generally a short life."

Having gotten over the definition issues, we then moved off to the first of our tasks, which was to talk about the demand for nondurable goods. We expressed the view that the demand for nondurables is relatively steady and is probably related to certain demographic issues and less related to government policy, except as how policy affects demographic and other factors.

These items or those issues that could affect the demand for nondurable goods are items such as population growth, the GNP and/or measures of disposable income, the work week, the effect of shortening work week and increased leisure time, age distribution through the society, regional shifts in population, and employment, among others.

Government policy could affect these through tax policies, housing policies, and so forth, and we should understand these relationships better if we are to work backwards and attempt to understand more about demand for nondurables.

This in turn emphasizes our point of the need for functional definitions of freight category. The link is only as strong as it will be clear and understandable and to the extent that we can get data. Obviously, this in turn depends upon clear categories. One of the single largest issues we uncovered was the need for data, which has been reflected by the other panelists, and data in the right category.

The first task for the panel, of course, was to talk about the demand, but we felt that wasn't completely clear. We thought it was equally appropriate to spend some time talking about modal split or modal distribution. This became a significant issue because, although demand for nondurables may be relatively insensitive, as the panel concluded, over the short run modal shift will depend upon some of its inherent characteristics and policy issues relative to investment and energy, for example.

As an example of this, Bill Smith noted that the issue of whether the railroads do in fact capture a substantial market for coal is going to have, in his case as a shipper, a very big impact upon the future of the shipment of cereals by a company such as General Mills. At the present time, a substantial portion of all of their cereals are shipped by freight. He said in his view, if the railroads fail to capture the coal market that they are anticipating, he doubts very much whether they will be in the position in the future to provide the kind of service characteristics that are necessary for his kind of commodity. They are watching this carefully, because the lack of ability to capture the coal markets in his opinion, would indicate that General Mills in the future is going to start thinking about different ways to ship their cereals.

The free market forces, we believe, will continue to serve a disperse demand as long as costs for transportation remain relatively low. But this could be affected by issues of investment in technology and energy policies. In the past, technical advances have overcome fuel inefficiencies to keep transport costs low. If this is not continued, these modes that are in less need of technology and that can replace or improve equipment through earnings will continue to dominate and gain a larger share of the nondurable traffic.

The effect of a government policy to make use of what we have in the transport section and not infuse money into technological research could have a very significant effect.

Examples we discussed: Air transport has not been fuel-efficient in the past. We have been managed, by technological infusion, some of it coming through defense research, to increase the economy and speed of our air fleet in spite of increasing fuel inefficiencies. On the other hand, if the cost of fuel continues to go up, and if something is not done about reinvesting in a more fuel-efficient fleet, the cost of air transport is going to start going up. I see a parallel between the issues of fuel costs and air transport and the problem of railroads and capital investment.

In general, however, a dramatic shift in modal split is not to be expected in the next 10 to 20 years. We note the danger of forecasting this sort of thing. There could be technological breakthroughs. The bimodal concepts could catch hold and have significant impact, but generally we don't anticipate dramatic shifts in modal split in nondurable goods.

On the subject of research needs, there seems to be a very clear need to better define the different categories of freight movement and to put the classification on a better functional footing. Past classifications are very likely counterproductive in this sense. This becomes clear when we review Dr. Lawrence's comment that we know very little about the actual movement from manufacturing, to warehouse, to distribution, to retail, and so forth. We know very little about the whole process, and as the panel on durable goods pointed out, we have to expend much more effort to get that information. However, I believe the extent to which we come up with good classifications will help us very much in collecting data and understanding the data. This may not be a concensus view, but my personal opinion is: We did talk about needed

research and modeling to some extent, but not enough to reach a conclusion. I would be very concerned about the idea of going out and collecting large masses of data, the type Paul Roberts calls the "hmm" variety, in the hope that one might come up with something useful. I have never, in my experience with science and technology, seen the circumstance where one collects data arbitrarily, collects data for the sake of having data, in the hope that something will be found. That is usually a very, very inefficient form of research. We would like to know what it is we are looking for, and I think the proper categorization of freight could help us in selecting what kind of data we want.

Another interesting thing about the need for that kind of data (that is, to understand the process to know just what is happening from the manufacturer to the distributor to the retailer and so forth, how it is moving, what are the processes that take place) is that, in the case of nondurables, there is a point in the whole process of going from raw materials down through various processes and assembling parts and moving them, where a group of materials and processes suddenly become a nondurable good. We don't know where that is, and it is different for different products, but it is important. Somewhere through that process, when it becomes a nondurable as I have defined it, its needs for warehousing, the impact of communication technology, the impact of service characteristics, becomes very much different for that product than it was for the predecessor components that went into making it. I think that is part of this data need, that we should understand things a little better.

The role of improved communication in inventory practices will affect expectations for the service characteristics of transportation and decisions to locate plants and distribution centers. Unless we understand this process better, we are again hobbled in making good policy decisions. Better inventory control affects marketing tactics and affects expectations on the part of the public in terms of how fast they want these products and what kind of distribution requirements are in fact expected; and, as these expectations go up, they will in turn affect where plants are located, where warehouses are located, and the kind of modal shift that will be affected.

In summary, I see a consensus for these recommendations: (1) conduct substantial research into the issue of how to classify freight, such that the definitions are functional with respect to demand and supply characteristics; (2) significant data-gathering is necessary to better understand the movement and service characteristics from manufacturer to warehouse to distributor to retailer. With respect to nondurable goods, it is important to know where the product changes its characteristic and imposes new demands on distribution and service; (3) linked to the above, the role of the communications revolution on marketing, distribution, warehousing, and so forth should be better understood, because this will have a significant impact on the role of transportation, not so much so on an aggregate demand, but on location and modal split. Needless to say, this in turn depends 100 percent on better data and classification of data; (4) policy issues relative to energy and technological investment will play a significant role with respect to modal split, and insofar as taxing policies, housing policies, and so

forth, will have some, although smaller, effect on demand for nondurables. Underlying all of this is the clear need for data and classification. With respect to the problem of classifying freight or coming up with freight classifications that will be functional and help us decide what data to get and get better data. I suggest that engineers be asked to do that, because what economists seem to have done with those classifications, so far, as I have seen, has not been sufficient for our needs.

DISCUSSION

DR. LAWRENCE: I don't want to defend economists for the classification scheme between durable and nondurable goods, but I would offer your group a word of caution. The classification scheme that I have used in the paper to which you referred is based on the separation between durable and nondurable that is given to us by the Department of Commerce, and all of the economic geographic data, all of the statistical data that is available from the government relative to commodity breakdowns are along that scheme. So it is not that they are intuitively appealing; it is just that if you are going to analyze transport data in something other than a vacuum, you are going to have to do it relative to the government data that is available.

DR. ROMUALDI: I recognize that, and was moderately facetious when I talked about that, but not completely. We seem to be hearing from everyone that we don't really have very much data now. I am talking as somewhat of an outsider in these economic issues. We have heard from several people that there simply isn't sufficient information available now to do some of the things we want to do, and the call seems to be frequently for just more extensive data-gathering. If in fact there is something wrong or nonproductive about the present classifications for these kinds of issues, then we better ask the question whether we want to continue being prisoners of the past.

Now, it may be, for the reasons that you described, that we are prisoners of the past, that the data are being collected that way and we are locked in. But I would like to examine that issue carefully and determine whether or not it has to be that way. I, myself, would not accept the past as the forerunner of the future.

DR. LAWRENCE: Could I offer one other comment? As a related comment from our group, we noted that if one might offer a very crude separation between activities in Washington relative to the economic decision-making process concerning hundreds of billions of dollars a year for either program or for, in fact, subsidy expenditures and investments in particular industries. On the other hand, one could identify those activities that relate to gathering the data and doing the research to provide the analytical input into those decisions.

On the other hand, hundreds of billions of dollars are being spent, and, on the other hand, just tens of millions relative to the analytical input. Maybe we have had things backwards for a couple of years, and,

if we are ever going to make informed economic decisions, perhaps we ought to spend the money now, bite the bullet, and get the data put together and possibly spend hundreds of billions of dollars.

DR. ROMUALDI: Well, I know many people who wouldn't object to that hundreds of millions of dollars being shared by every university within shouting distance.

Aside from the practical point, I want to be honest; I don't know this business of classification, because it is a very delicate area. I look at this as an outsider, as an engineer. I don't want to overwork that point. But as I look at that information, I have found it very difficult to understand any logical reason for categorizing the way I saw it from a functional point of view. I know there are historical reasons for that, and I want to leave it on the point that if, in fact, different classifications will help us understand the data once we get it, I still think we should change.

DR. ROBERTS: I just want to offer two comments. Since our panel invented "ho hum" data and "hmm" data, by definition, "hmm" data are very efficient and very small.

DR. ROMUALDI: Well, I misinterpreted what you said, then, and you might clarify the point. What I heard you say was that one collects data in the hope that one will, in looking into this data, find something like Madame Curie did--find uranium in the pitchblend. Then it becomes "eureka" data. So will you explain what you mean? Let's find a different name before we start.

DR. ROBERTS: Yes, I think it is very useful, and I would welcome any comment, but I think it is very useful to have some ideas and say, "Hey, let's go test that in the real world." So we gather some data and we look at the data, and we see the original hypothesis was wrong. Now one can have a new and slightly revised hypothesis. At that point one gathers some more data. We are not in that kind of a framework in this business right now. We have some very long-run data collection programs that gather thousands of observations, but that no one can then look at later on for various reasons.

DR. ROMUALDI: Then I agree with you.

DR. ROBERTS: So what we like is more ability to say "hmm, let's go out and gather a little data on such and such." The other one is that universities are terrible places to gather data. They could gather 'hmm' data perhaps, but they are just the world's worst place to go to try to solve the unemployment problem.

MR. SOORIKIAN: There is perhaps one major reason for collecting data. In the world of decision-making by the user, there are all kinds of people who ask questions. I think if we could make the decisions right here, we wouldn't need the data. We are the experts; we know exactly what is needed in the transportation distribution network. But the person who is responsible for the profitability of an operation, the bottom line, doesn't really know what the data is. That is precisely the reason to collect more understandable, better data.

ENERGY COMMODITIES DEMAND

Leon N. Moses
Director, The Transportation Center
Northwestern University

On our panel were representatives from the coal industry, from industry other than coal, railroads, some members of government research teams, and an academic--myself.

We are pleased that there was considerable agreement among the members on the major conclusions concerning coal transport, and therefore we have something to offer the people who are doing overall modeling of transportation. We found that it is necessary to consider the simultaneous interactions of production places, consumption places, and transportation costs and service; and that they are simultaneously determined. One cannot go about making a national forecast, then make regional forecasts without regard to factors that bear on regional comparative advantage, then ask where there are transportation bottlenecks, and ask whether it is necessary to build new waterways or new this or that. Rather we believe that the cost of transportation and the quality and amount of transport capacity was something that entered into the determination of what would be market demand and what would be produced in different places. I will enlarge upon this point later in this report.

The major conclusion was that the increase in energy needs in this country would be provided in very substantial measure by coal. That was something we all knew and expected from the outset. Our view was that the expansion in coal production would be the result of both economic and political factors. The political factors pertain to the continued desire to achieve considerably greater reliance on domestic energy sources, even if independence is a far-fetched or unrealistic goal.

The economic reasons for the expected expansion in coal production and consumption derived from the belief that the prices of competing fuels, petroleum, and natural gas will continue to rise. Our view on the price of petroleum is that the expected increases in price will not, in the long run, be the result of a cartel such as OPEC, but rather of real economic forces, the continued growth in GNP around the world, and the need for fuel and petroleum for powering electric plants, industrial use, etc. We are not saying that we look forward to rising prices because of monopoly, but that we look forward to rising prices because of basic economic forces. Further, in the line of economic reasoning,

we view the decontrol of natural gas and the resulting increases in its price as leading to an increase in the consumption of coal by industry.

Up to now, the greatest expansions in consumption of coal and the plans for expansion are accounted for by the electric public utilities with relatively little increase in the use of coal by industry. However, the future is likely to see some significant increase in the amount of coal consumed in the industrial sector.

We did have available to us some figures on production and consumption. There are many forecasts and projections being made, but we had a set that drew partly on a direct survey of electric public utilities and partly on research from various government agencies. We explored with the government people on the panel whether the figures agreed roughly with current thinking in Washington and found that they did.

Table 1 depicts coal requirements by broad industrial sectors and regions: electric public utilities, industrial use, coke plants, and total; Northeast, Central Eastern and Midwest, Southeast, West, and total.

TABLE 1 Demand for U.S. Coal

	Electric Utilities		Industrial		Coke Plants		Total	
	1976	1985	1976	1985	1976	1985	1976	1985
Northeast	66	79	9	12	36	40	111	131
Central Industrial and Midwest	147	221	28	38	32	36	207	295
Southeast	131	180	15	22	10	12	156	214
West	111	280	16	23	6	7	133	310
Total	455	760	68	95	84	95	607	950

Exports in 1976 were 59 million and may be 75-plus million in 1985.

SOURCE: Annual Report to Congress of the Energy Information Administration, 1977.

We are talking about moving from a requirement for 607 million tons of coal in 1976 to some 950 million tons in 1985, and that does not count exports. In 1990 we are talking about moving up to 1,255,000,000 tons, including exports (Table 2). That is an immense expansion in the amount

of coal that is foreseen to be consumed. Referring again to Table 2, it shows eastern and western coal production and consumption. The table, therefore, portrays the level of consumption of each region, and the interregional production trade or shipments.

TABLE 2 Production and demand in 1985 and 1990 as compared to 1976 in millions of tons

1976 (Production)	1985	1990
406 Appalachia	457-463	502-521[a]
136 Midwest	221-222	244-264
25 Central West & Gulf	63-63	97-112
11 North Gt. Plains East	32-32	43-46
57 North Gt. Plains West	184-202	286-315
17 Rockies	24-24	29-30
20 Southwest	46-46	50-53
5 N.W. and Alaska	7-7	7-7
677	1034-1059	1258-1348

[a]Higher world oil prices, i.e., 5 percent real annual increase after 1980.

We have a considerable amount of coal moving between the western region and the eastern region, and that is an indicator of the kind of transport capacity problem or transport cost problem that has to be faced.

If we are going to move from a production in 1976 of 677 million to 1,034,000,000 in 1985, and 1,258,000,000 tons in 1990, the question is how to move it. What transport will be required? We didn't have firm quantitative figures available at this time to tell us what amount of different kinds of capacities would be required. Such studies have been done, and it is suggested that research be done on those projected quantities of coal produced by region and moved by barge, rail, and truck.

Using the 1034 and 1258 figures above the East/West movement looks like this:

	Eastern Coal		Western Coal		Total	
	1985	1990	1985	1990	1985	1990
Eastern Consumption & Exp.	655	720	90	165	745	885
Western Consumption	25	25	265	345	290	370
Total	680	745	355	510	1035	1255

SOURCE: Annual Report to Congress of the Energy Information Administration, 1977.

We did not have and did not use the modal split of figures available at the present time, but we did have some qualitative insights of an important nature. First, we looked at the movement of eastern coal to points within the East, and the problems there were not overwhelming in a transport sense. Additional equipment was going to be needed, both motive power and hopper car, and there would certainly have to be improvements in track and right-of-way, particularly for ConRail. Further, improvements in ConRail would do a considerable amount in helping improve overall car utilization in the East, because at the present time cars that are delivered to the ConRail territory tend to stay there for much longer than they are really needed for unloading purposes, and, to the extent that the ConRail right-of-way and management can be improved, we can get improved car utilization in that area.

Still focusing on transportation from sources in the East to users in the East, one of the reasons that we don't see overwhelming problems is that shippers can rely on the inland waterway system. Recognizing that there will be bottlenecks, delays, and undoubtedly some investments in locks and dams, we did not give serious review to the question of the use of user fees to finance such investments.

There is some possibility, though not very great, that some amount of coal in the East to East movement can go by pipeline. In the East, there is not the severe water problem that is experienced elsewhere in the country. Let it be understood, we are not talking about moving huge quantities of coal by pipeline, nor is it clear that in every case the pipeline can always out-compete a railroad. There is one particular coal company that did build a pipeline. After building the pipeline, the company was offered lower rates by the railroad, and now that pipeline is unused. The fact remains that in the East there is some possibility of moving coal by pipeline over relatively short distances. The point was made that in the East there are some regulatory problems associated with the conversion of existing pipelines from their current use to the transport of coal. The regulatory problem arises because the pipelines were built on condition that commodities currently moved by rail would continue to move by rail unless rail, in effect, gave permission to have those commodities moved by pipeline. If I leave you with the feeling that we are rather sanguine about the possibility of moving the greatly increased quantities of coal within East that originates in East, that is the intention. We are not saying there are no problems, but they are not overwhelming.

The biggest transportation problem is in the movement of western coal, and here we began by looking at some technological alternatives to the movement of coal by rail. The possibility of mine-mouth electrical power generation and high voltage transmission was considered and found not likely to become a viable alternative to rail transport in the time period under consideration. There are three reasons for this. Two of them are environmental. First, to generate all that electric power in these western states is in effect to turn those states into the nation's smokestack, and it is doubtful that these regions would accept such status.

There is a second environmental factor. This has to do with the magnetic field that is set up by high voltage transmission.

There is a final point on why we do not consider mine-mouth generation to be in the picture in any significant amount, and this is an economic argument. It is only viable, apparently, to transmit power by direct current. In these new methods that are being talked about, it is only economically viable if you do so long distance, without drawing off power along the way. Yet, the distribution of consuming points in the United States is such that power would have to be drawn off. That situation is not found in the Soviet Union, where power is generated in Siberia and transmitted 2,000 or more miles without interruption.

A second technology was considered and that was the use of coal slurry in the West. This didn't appear to be economically feasible because of the very severe water problem. Some of the engineers with whom we spoke indicated that, in moving coal by pipeline, the ratio of coal to water is on the order of 1 to 4 or 5. If we are considering the movement from the West of the quantities of coal I gave you earlier, that will mean an immense quantity of water will need to be provided by regions where water is scarce. The alternative of reusing the water, which is to say pumping it back to the point of origin, is very expensive.

I leave out the obvious problems of rights-of-way, of environmental impacts, and all the usual difficulties that occur when you are considering the building of a new pipeline.

That leaves what amounts to a rail alternative for the largest part of the movement of western coal. The question then becomes, what amount of money is going to be required to upgrade rights-of-way to put in and replace track as required, and to buy the additional motor power and cars? We had no firm figure for the entire industry. There was a relatively firm figure from one of the railroads amounting to some $4 to $5 billion, and a guess was hazarded that it might be as much as $20 billion for all. That is a great deal of money, and there was great concern about how this money would be raised by an industry that has a record of such poor earnings that it cannot possibly go to the capital market under present circumstances.

It was observed that, while the required investment is certainly great, it is not as great as the amount of money required to build the electric generating plants that are included in the energy plan, to build the amount of additional coking plants entailed in the energy plan, to actually put the mines in operation. The sums involved are much greater than $20 billion. It was also observed that there does not appear to be any doubt that the electric public utilities will raise all the money they are going to need for the generating plants, and that the railroads will be unable to raise the money they need to expand capacity. Part of the answer is to be found in the way the two industries are regulated. Electric public utilities are subject to rate-of-return regulation. If the rate of return falls below a certain level, rate increases are forthcoming almost automatically. The electric public utility in effect is regulated in a way that protects its rate of return, whereas the railroads are still regulated on the basis of some nineteenth century concepts of their monopoly position.

The resulting conclusion was that it would be difficult for the railroads to raise the capital needed to expand capacity unless the ICC changed radically its approach to regulation. The ICC must be persuaded to be much more liberal in granting the appropriate preinvestment rate increases, not "I will give you a teaspoon of food today and perhaps one tomorrow," which cannot be the basis for raising funds in private capital markets. Indeed, since the movement of coal by the inland waterways is exempt from rate regulation, it might be best to extend the exemption to railroads. If the railroads attempt to exploit the position of dominance they have in some regions in the movement of coal, other modes will become viable competitors.

It was noted that the railroads would have to make some adjustments themselves, and that in particular they would have to work to increase labor productivity. If this new commodity moving in large quantities is made the basis for a whole new set of excessive labor demands, either wage or work rule, that are granted, then changes in regulation will not accomplish their purpose.

In terms of research issues that I mentioned earlier, we looked at these in a qualitative way. We must ask, "Where is the coal likely to come from?" We looked at it as a classical location problem with simultaneous interactions on production, consumption, and transportation. Coal reserves and their location are well known. The qualities of the coal available in different areas is known. Cost of production of coal in different areas is well known, or at least can be estimated with a fair degree of accuracy.

This gives us in a sense the supply side of our equation. Estimates had been made of coal requirements in different parts of the country. It is interesting that in looking at what amount of coal is likely to be produced in which region, the coal companies themselves were making estimates as to what the transport costs would be to various markets from various production places. At the same time, the railroads have some notion of what they are going to have to charge to move that coal. One can ask the question, "Are the two working on the basis of the same assumptions about what the transport costs are going to be?" That effectively, is the kind of simultaneous interaction I was talking about earlier. Some adoption of this kind of reasoning is required in the overall study as well. It is a classical location problem to determine points of possible production and the cost functions associated with them, points of possible consumption and the demand functions associated with them, and the network of transportation costs and how they interact with the two.

We are anxious to examine the outputs of the models that have been used to project movements of coal by barge, by rail, and by water. We wish to see how much congestion they entail on the wateways. How much queuing is there going to be at the locks? In other words, we wish to look at the results that are available for detailed routings of coal and to judge the costs of the movements, the capacities required, etc.

Some of the conclusions were based upon the electric power industry's own forecasts of consumption. These forecasts tend to assume high income and low price elasticity of demand. I am not completely satisfied

with those assumptions. However, I should point out that the demand for electric power may be more price elastic than the power companies assume. They may be underestimating how much conservation may take place through the reduced use of appliances, etc.

DISCUSSION

DR. ROMUALDI: Just a question relating to one of your last comments about elasticity of demand for electrical energy. On what do you base that? You said that you believe there is a price elasticity. You raise the price high enough and people will stop using it. Within the expected range, on what do you personally base your conclusion that people will cut down the use of appliances and electrical energy if the price goes up? I don't, however, say they won't.

DR. MOSES: I base it on fragmentary evidence. It hardly even qualifies as the word "evidence." There was a time when electricity was being used by contractors and builders as the sole source of heating, cooling, cooking, etc., in condominiums, apartment houses, and homes. I believe that that has come to an end; that kind of construction has just about ended.

I think that even in the appliance industry there is much more attention paid to power efficiency, and people are being urged to look for power rating on different utilities and they are doing that. So even though you have a high income elasticity and you continue to buy refrigerators and other things, I think that there is a second-order effect to begin to watch, and that is, which appliances are more efficient and which are less? So I think that there is a tendency on the part of people to behave rationally and to conserve on something that is tending to become relatively expensive.

DR. HERWALD: I think the thing that was most interesting about your presentation was that it is going to be impossible to track all commodities in all directions; the type of thing some of the studies would like to see done. There is a general relationship that you brought to our attention that says, if we pick the largest 20 percent of the commodities that go from raw materials through the processing and out to the user, one will come up with 20 percent that is probably worthwhile doing. I think you would get more out of those types of studies. And I think, out of those types of studies you will get a big enough percentage of the total transportation that you can put all other into some category and let it go.

DR. MOSES: I would like to voice my agreement with that in the following way. Take coal. Surely it is one of the most important products to be analyzed in a study of transportation. Supposing a very detailed study of costs of production in different regions was made, and similarly a detailed analysis of transport costs, etc., and that we were then to confront the overall model with the results. Suppose the two did not agree, what would we say to the people who did the detailed

coal study, "Go back and change your micromodel, because it does not agree with the aggregate study?" Would we tell the overall modelers, "You have missed something; there are substitutions that have not taken place in your model because, for example, your production functions all involve fixed coefficients and you have no locational analysis of industries, regional allocations being carried out mechanically?" I think I would have a tendency to place somewhat greater credence in the micromodel than the macro. So, in a roundabout way, what I am saying is that I agree with you.

OTHER BULK COMMODITIES DEMAND

Jerry D. Ward
Massachusetts Institute of Technology

My remarks will be concerned with all those things that are bulk commodities that don't fall in the energy category. "Other" means bulk without oil and coal. It includes things like agricultural commodities (grains, etc.), industrial chemicals, fertilizers, ores of one kind or another, primary metals, etc.

Dr. Nelson posed two questions when he asked that we participate in this workshop. First, What are our expectations for demand for movement of these commodities over the next 10 to 20 years? The second, what are the implications of this demand on the need for data and for research and analysis? My job is to report my view of the conclusions of the members of this panel, which I think was a reasonably effective group. It was blessed by having a few people on it who actually understood the problem.

The first thing we quickly found out was that one really can't talk about demand without talking about supply. It was inevitable, then, that a good deal of the discussion turned to the problems of supply. The second thing that I noted was that it is very hard to focus on 1995 when you are "up to here in alligators" right now. Therefore, the distractions of the problems of 1978 were continuously recurring in our discussions.

The combination of those two points--that one can't ignore supply while discussing demand, and that one can't forget today while we are talking about tomorrow--led us to spend a fair amount of time talking about the plight of the railroads. The reason for this is that ours is a commodity group that is highly dependent upon the railroads. It was brought out that International Minerals and Chemicals, for example, ships 87 percent of their materials by rail. The typical shipments are in very large quantities, and the economies of shipment are primarily the result of achieving these high levels of aggregation. It is natural that the rail and water modes that are suited to large batch movements dominate transportation of most of the commodities we addressed.

Before discussing the observations with respect to the railroads and future demand, I will summarize some general observations on task number two, the need for data and analysis.

The general conclusion was that we should go slow on recommending new research and new data collection. Jim Springrose made the point that government R&D should pass the same criteria for potential payoff

that a private company would require for their research and development. Data costs money and research and development costs money, and it is very easy to fall into the trap of working on something because it is there, because there are always more questions than answers.

There are those of us who do lust in our hearts for data and for analysis. But the admonition was to exercise restraint, to restrict data collection and analysis to those situations where one knows why following a trend is important, or where one really has an idea that something can be improved and data and analysis can help test the hypothesis. The point is to look only when you know what you are looking for, why you are looking for it, and what your objectives are.

Now, there is a dilemma in all of this that I can illustrate by describing one of the short interchanges that we went through in the course of our deliberations. The suggestion was made by one of us who receive our salaries from the taxpayer that a certain area should be studied. I must say, on the face of it, it sounded very reasonable and rational and there appeared to be a real payoff in the knowledge that would be derived. The counterargument was that the private sector does this kind of study every day in the carrying on of its business, and it already knows what the answer is. That observation would be a very legitimate and satisfactory reason for saying, no, the government doesn't need to do research in that area, or get any data, and let's not worry about the fact that the data that the private sector has is proprietary, if we are still depending fully on Adam Smith's invisible hand to run the economy. The dilemma is that, fortunately or unfortunately, we have worked our way around to the point now where the invisible hand is getting a lot of holding and guiding from the very visible hand of the government. The result is that the government often finds itself in the position of having to repeat research and having to independently verify and independently collect data of one kind or another.

However, the general conclusion reached was to go slow, to do this carefully, and try not to overdo it, because all this data collection and analysis is a burden on the economy that's a lot bigger than just the direct costs.

Let me switch subjects slightly from the one general point that I made and address the demand for movement, which was the number one question. We made no attempt to cover everything. There are lots of things that we know will change, but will change in such a way that there is lead time for the system to adapt to the changes that are coming. In these cases there is no real need to predict what is going to happen in 1997, and there is no real need to argue now whether the rate of growth is 3.2 or 3.5 percent, because that really only argues about whether you have to do something in 1994 or do it in 1998, and, as of today, we really don't care much.

Consequently we didn't spend much time on such matters. We were really searching for the trend changers, the kinds of things that would be the surprises. This would be either because little overlooked things crept up on us over a period of time and then finally surprised us because they had suddenly gotten so big, like air pollution, or because there is going to be some change in the dynamics, the nature, or source,

of causality that affects what is going on.

Looking in the area of agriculture, the U. S. Department of Agriculture forecasts substantial rise in domestically grown grain shipments in the near to medium term. There wasn't time to dig into that forecast a great deal, to see what made it up. There was, however, a feeling on many of our parts that perhaps some of this anticipated "growth" in domestic grain movements is a bookkeeping problem in the following sense. If a farmer switched from growing his grain and feeding it to his own cattle, to growing grain and feeding it to his neighbor's cattle, it becomes part of the transaction and, therefore, it looks like there has been a growth in the output, with an apparent implication for a new transportation requirement. This kind of shift toward increased specialization is happening; how much it affects the picture is not known.

In any event, projecting forward, it appeared that the domestic consumption of agricultural goods was tied to population. In the longer run all of the signs now are for a declining rate of population, and therefore a declining rate of growth of domestic consumption of agricultural goods, and the concomitant implications for transportation that goes with that. However, surprising changes in the mix that would have transportation implications are not anticipated.

These observations are not true for the international market. There is likely to be substantial growth in the international market, growth of a nature that is fraught with many vagaries.

One of the major problems that agricultural commodities pose for transportation is that there are violent fluctuations in the demand for movement over time. Part of this fluctuation is seasonality; certain things bloom in the spring and certain things bloom in the fall. The first need for transportation is to either to the point of storage or to the consumer, and it matches the seasonality of the growth cycle.

The fluctuation in demand for international shipments, though, is not necessarily determined by the seasonality of growth; it is more in fact determined by the seasonality of growth someplace else, political factors, events in the rest of the world. Because we do have substantial storage capacity in this country, we have that kind of buffer that makes international "demand" to a degree independent of the supply characteristics that are found here. There are, though, violent changes in international prices in response to these multitudinous influences. One of the areas of research that looked sensible, and that is recommended is to try to get a better understanding of the price elasticity in the agricultural market.

These same kinds of considerations also apply to some of the other items, like scrap metals. Jim Springrose characterized the business of Cargill in saying that if they had a kind of central expertise, given the vast number of kinds of activities they are in, it is the expertise to cope with the risks that are inherent in a market that has violently fluctuating prices associated with it. That is the agricultural market in spades.

There is just no question that the agribusiness is far more than a domestic business, that its primary growth depends on the rate of growth in the developing world, and understanding the world is the key to under-

standing the potential growth in agricultural commodity transportation. Growth is dictated by political as well as economic and demographic factors, and research in understanding this better is important for two reasons. It is important to the people who are actually in the business, who are perfectly willing to do their own research. But it is important to the government because, whether we like it or not, the government makes policies with respect to prices and to sales of agricultural products. It also makes policies with respect to the allocation of transportation equipment in the country.

A case in point is the recent allocation of hopper cars to the movement of grains. It was a situation where there was little doubt that grains needed moving, but at the same time fertilizer needed moving also. I think I'm reflecting the attitude of the people who represented both of those industries in our group when I say that the allocation of the cars to the grain movement didn't do much good for grain, and it did a lot of harm to the fertilizer side. So research that would help the government make more sensible policy decisions in the face of these recurring crises would be very helpful. Such problems are not going to go away.

The dependence on the railroads by people in these kinds of businesses forces them to be very interested in the problems of the railroads. We discussed several. High on the list is the bad track problem. It is a fact that it is real in certain places, but it is not certain just how real it is in terms of the main line track. It was recognized that it is partly traceable to suboptimizing, to poor financial health, and to the discrimination in financing that railroads face where they can get money for new cars, but can't get money for fixing up track.

Another "problem" is the so-called freight car shortage. After a little discussion, there was considerable doubt raised about whether the freight car shortage was the root of the difficulty. There was some opinion expressed and concurred in that the real shortage may be in the locomotives and in the yard congestion that is created, more than it is in an absolute shortage of freight cars. The probable solution, if there is a freight car shortage, is in better utilization and better ways of settling conflicts between alternative kinds of demands.

I discovered something I didn't know, and that I suspect most railroaders do, which is that people who sell fertilizer and people who deliver grains have joint leases on cars that they allocate back and forth between the two tasks when fertilizer is needed and when grain movement is needed. But independent of what the true nature of the problem is, it is used to improve the operation of the railroads. Much of what deviation there is from railroad traffic or from waterway traffic is due to a lack of good operation, which has caused some shift of traffic that would normally stick with the railroads. This is particularly true of chemicals, to which I will now switch.

It was noted that industrial chemicals would grow basically with GNP. Hazardous chemicals and materials make up some 6 to 8 percent of all shipments, and that these will probably grow relative to the total in the future. The issue of how to handle hazardous materials better is

one that is going to become more important in the future. There is a certain concern that the publicity that is now being leveled on this problem may encourage a shift to movement by truck. The feeling was that this would be a mistake; that inherent in the technologies is a much better opportunity for better safety on the railroads and on the waterways than there is on the highways. The effort should, in fact, be to try to improve the way hazardous materials are handled on the railroads and the waterways, and to take advantage of those inherent capabilities in order to cope with the fact that growth in the movement of hazardous materials is inevitable. The general effort now on the part of the people who are moving bulk chemicals is to encourage a modal shift from trucks, because of safety and cost reasons, toward rail. The need is greater dependability out of rail, so that inventories could be kept reasonably low, whether their inventories are those of the receiver. They are also encouraging a shift toward water, because of the anticipation that water modes will probably enjoy a lower rate of inflation over time than will either truck or rail.

The central message that has emerged from all of this is that over time we are going to have change. The change can take place in three different ways. One is just the basic growth of movements, and as long as they are reasonably slow there is no reason why the transportation system can't adapt to those changes as they go along. There will be shifts in the pattern of origins and destinations that will change the pattern of travel that takes place. The change in origins will follow from both new sources of the raw material and new mixes and kinds of the output bulk materials. The redistribution of destinations will come about partly because of demographic shifts in the country, partly because of a shift toward international markets as opposed to domestic markets, and partly because of spatial reorganization of the processing of the goods and materials involved. This relocation of points of processing--that is, where do you grind it into flour, where do you grind it into soy meal, etc.--will come about because of the changing capabilities of the transportation system, as well as the changing pattern in the markets themselves.

DISCUSSION

MR. DAVIES: I would like to step out of the role as carrier representative for a minute and make a comment, not ask a question. I think the presentation that Mr. Ward has made strikes a very responsive chord with me. I have heard a lot of discussions in the last day, both in this room and out in the hallways, of the need for a great deal of detailed information, some of which I feel was responding to needs of the individual companies expressing their concerns. I don't think they were in the purview of the federal government. I think that is the kind of framework that I see the conference in, demand forecasting for purposes of the federal government, essentially for policy implication

factors. I don't see the need to get into detailed microforecasting for that kind of purpose.

In addition, I have the inherent bias that, if you give the government that kind of detailed data, it will be misused. I was in the federal government and misused some of it. What I am trying to express is that we ought not to be concerned about detailed aggregate demand forecasting simply for the sake of that forecasting. We have to look at the end use, basically public policy implications. That is what the federal government has to try to sort out.

From my point of view, we can go through a great deal of detailed forecasting, and the comments that I heard from Al Davis yeaterday, that Carnation would ship canned goods by truck rather than by rail if the service didn't improve, has much more significant implications than a great deal of demand forecasting. That raises a public policy issue that has to be addressed. Do we want the railroads to move canned goods? Who cares? Maybe we don't want them to move canned goods. Maybe we don't want to pay the costs. That is a public policy issue that has to be dealt with.

I don't think we ought to get into detailed demand forecasting simply for the sake of it. We ought to look at the end product.

MR. BLAIR: Mr. Ward, in a portion of the material you were presenting, it wasn't clear whether you were saying we needed a long-term or long-range forecast or a long-range plan, or whether we could operate on a short-term basis.

MR. WARD: My feeling is that we do need to think into the long-range future, but not in every aspect of our lives. There are certain things that we can expect to unravel in a way that is slow enough that we have no question of our ability to adapt to the changes they imply. The reason for trying to think ahead is to not be surprised by those other changes that might not give us adequate lead time to react to.

I think we should think ahead as far as is relevant to the particular issue at hand, but I just don't see much point in quibbling over numbers that don't really matter right now. There is a lot of effort going into estimating numbers that apply to some point in the future. Then you ask yourself, if I change it 25 percent, how will that change the way you behave tomorrow? If the answer is, I don't know, then why worry about it.

MR. BLAIR: I was directing this toward the fact that for any major movement or reestablishment of any type of facility, whether it be highway or rail right-of-way or airports, needs to, in my opinion, be planned by a conglomerate of commodities on a long-range basis, because as industry, we use it on a daily basis, or on up to at least a 5 year basis, but in a 5 year basis you can accomplish improvement in roadbeds, airports, or highways. And that was the thing in our panel that we really felt, overall, was directed to an end point of 1995 to 2000, where we would have either reconfirmed that our present facilities are being expanded in that direction or that new facilities need to be developed.

MR. WARD: It seems to me that one of the important questions in all of this demand forecasting is just that point; that if, in fact, we establish that, there are going to be major facilities expansions re-

quired of the transportation system in, for instance, the next 25 years, then that tells us that somewhere along the line we are going to be spending a large amount of money to make that expansion.

That, then, raises a second question. We should really think through how we want to spend that money. Do we want to invest it in more of what we have, or do we want to take that as an opportunity to do it some other way? If the first answer is no, we are not going to have to make any major expansion, then that is a different situation. But if we are going to be making big investments, then the question of what is the best way to make it, is highly relevant. I personally have a bias that we are not really thinking very hard about this second question.

MR. BLAIR: I follow your thinking, and again, reflecting on the past and looking into the future of what transportation is needed, it has grown every year. Knowing what industry is doing over the whole country, I enthusiastically support some type of long-range plan that brings these things together. I agree that the minute details of that 25 percent tomorrow doesn't have any bearing, but what a sampling is going to tell us on the movement of people and industry, and everything else, will have a bearing on what those facilities are in the future.

MR. WARD: Yes, I agree.

MR. GORHAM: I was on the Aggregate Panel, and we got into this question of a long- versus short-range forecasting tool that wasn't brought out so much in the summary. I think the essential thing that we focused on is that most forecasts are only good in a very short term, maybe 5 years, if you are lucky, a little longer; but on the other hand, depending on where you are in the stream, you may need to think further. And the particular case in point--I am doing some work for NASA. NASA, in developing aeronautical technology, has to think in terms of the technology that the manufacturers are going to need 10 to 15 years from the time they develop it. Add 10 years to develop it, and you are talking about 20-year forecasts. It doesn't do them any good to say that we can't forecast accurately more than 5 to 10 years.

So what you are thrown back on is the necessity to develop the best forecasts you can, preferably two of them, and try to spot the things that may prove you wrong. Warn your client that there are things that are going to prove you wrong, and try to give him the things that will give him an early warning indicator of some shift.

MR. WARD: I feel like I have found myself on the side of not advocating thinking ahead and being in favor of only worrying about the short range. What I am trying to say is that the thing I am concerned about is that precision in forecasting is not only impossible, it is usually unimportant. Once you have decided that something is going to change by a large amount, rather than a small amount, and whether it is going to take place in small steps instead of big ones, one is in a position to plan on how to cope to some degree.

SUMMARY

Donald S. Berry
Walter P. Murphy Professor
of Civil Engineering
Northwestern University

This is just a brief summary of what has taken place, dealing in part with what was done yesterday and in part with what was done today. We know that our speakers at the plenary sessions yesterday presented a wide spectrum of valuable information about freight transportation demand, not only tracing the history of demand growth and change, but also presenting forecasts of national growth in commodity freight movements. We were given some insights at the beginning to the sophisticated national modeling efforts of the Wharton Econometric Forecasting Associates, as well as to the regional forecasting models of the National Transportation Policy Study Commission. We may not all understand all of the details of those models, the kind of inputs that are needed, or the kind of coefficients that are needed in order to make them work properly, but we do know that they represent an extensive effort. They are, as I see it, very valuable additions to the state of knowledge. These models will be even more valuable as we get data needed to better calibrate them and run sensitivity tests for the many different variables.

We have also heard representatives of a number of the shippers describe examples of trends in durable and nondurable goods industries. For example, Dr. Herwald pointed out that in the Westinghouse Corporation there has been a substantial shift from rail to truck in the movement of durable goods. He also told us that overall costs, including utilities, taxes, labor, and the design of the plants to be of the proper size and to be manageable segments, rank ahead of transportation among the factors affecting decisions about location of Westinghouse plants.

As noted, in Westinghouse there are specialized plants that manufacture just one type of commodity rather than a wide variety of products. In the nondurable goods area, Mr. Davis of the Carnation Company pointed out that the superior quality of service of the truck, in terms of dependability and delivery time, has resulted in a continuing shift from rail to truck for their types of goods. That doesn't mean to say that all types of goods are shifting toward truck, because there are still the bulk commodities. Mr. Springrose and Mr. Dotter dealt with movement of grain and coal for export. These commodities certainly will continue to be rail-oriented and barge-line-oriented in their shipment patterns.

The two final speakers yesterday in the plenary session were representatives of rail and truck carriers. Mr. Davies of the Burlington

Northern Railroad outlined the large capital expenditures his company has been making for facilitating the growing movement of western coal. He mentioned, of course, some of the problems of raising money for the company, because the record of low rate of return on investment makes it difficult to compete in the money market for the kind of capital that Burlington Northern needs.

Dr. Lawrence of IU International pointed out that estimates of general trucking growth in truckload lots closely parallel the economic growth forecasts, whereas forecasts of LTL freight show that LTL freight volumes are lagging behind, due in part, perhaps, to the labor-intensive nature of LTL operations.

Practically every speaker pointed out that our forecasts are limited by the availability of adequate data. Dr. Lawrence, for example, said that it is difficult to analyze growth rates for motor freight transportation because so little data is available concerning the role that freight transportation plays in market distribution systems. Such systems include not only the producer and the ultimate consumer, but also include the wholesalers' and manufacturers' distribution facilities, warehousing, and other support elements. It is rather difficult to keep track of all of these types of freight movements. This problem is complicated also by the growth of the private carrier and other types of motor carriers, sometimes called gypsies, for which there is little or no freight movement information available.

Today, we have had excellent presentations by the chairmen of our panel sessions: Paul Roberts on aggregate demand and research; Bill Blair, durable goods; Jim Romualdi, nondurable goods; Leon Moses, energy commodities; and Jerry Ward, other bulk commodities. Although these are all fairly fresh in your memory, Paul Roberts does plan to summarize the research suggestions. I do want to say, however, that I thought these speakers contributed some very excellent ideas. We also heard from Paul Roberts some new and interesting categorizations of demand data, such as the "hmm," meaning "we don't know exactly what we want," the "ho-hum," the type of data base that "just sits there" and doesn't give us much new information, the "ah ha," the base that turns out to be a "good" one, and the "wows," the type of base that gives us a pleasant surprise.

So that we can get a little better idea about the problems with respect to data limitations and the need for improved data collection systems both for large data systems and smaller type data systems, I am now going to call upon Dr. Roberts to summarize the research suggestions that may lead to improved freight demand forecasting and to better freight data systems. Then we will open the session to comments, questions, and discussions.

SUMMARY

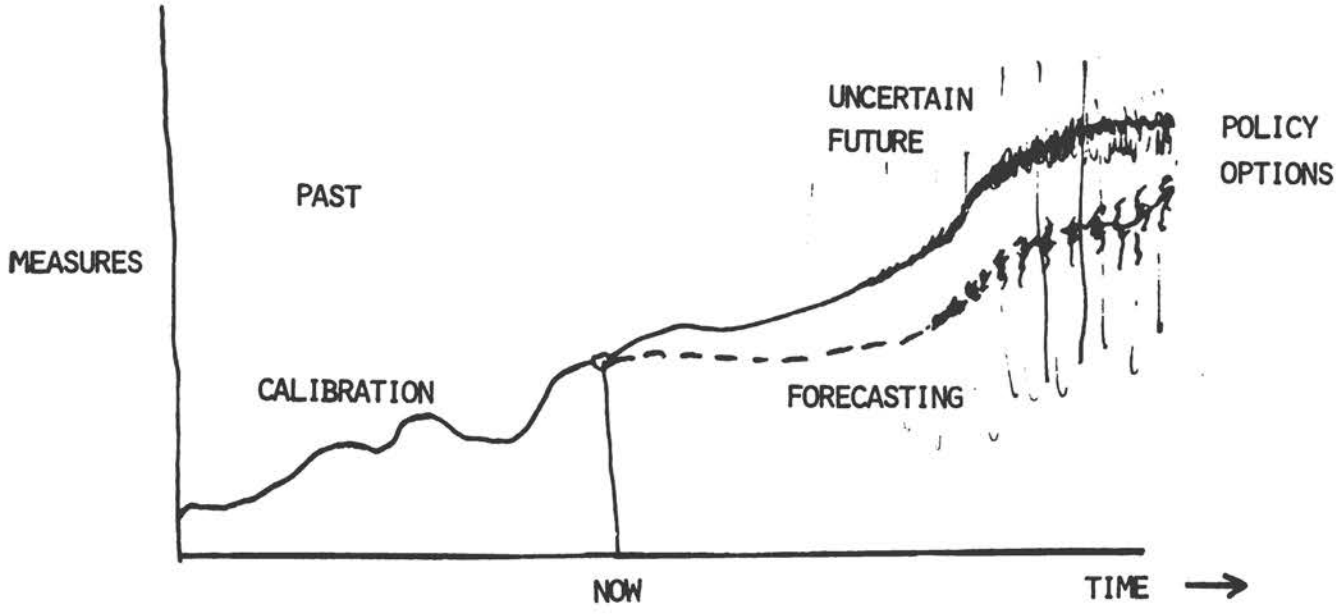
Paul O. Roberts
Professor of Transportation
Massachusetts Institute of Technology

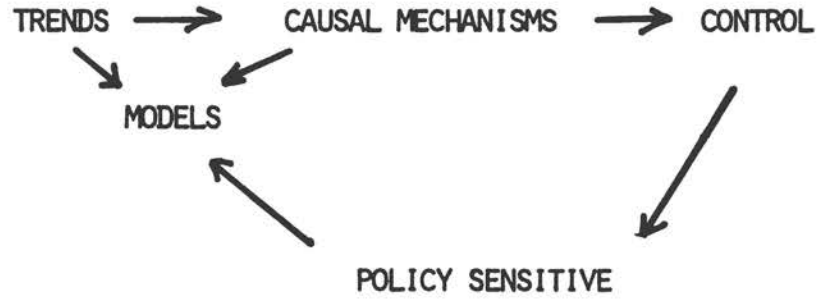
To summarize this session, I believe I would like to review two additional ideas that might be discussed a bit further. These concern research expectation, but I should be more specific.

During this workshop there were discussions about how the data available might be used: first, to understand phenomena, and, second, to understand causal relationships. Knowledge of causal relationships is then frequently expressed mathematically in the form of a model. The model is useful because it allows us to forecast the implications of various proposed policy options. Therefore, an important use of data is to structure and program models. These are models that use data that is on the left hand side of the "now" line in Figure 1. On the righthand side of the line is someone's estimate of the alternative futures that might occur as each of the policy options is selected. Regardless of whether the forecasts are short-term or long-term, they are still a best estimate about what might happen in the future. Whether a formal mathematical model is used, or whether it is an extrapolated trend, or whether it is just common sense, the forecasting side, the right side of Figure 1, is always derived from the left side. Everything starts from data, and everything would, in those terms, involve a model, whether the model is implicit or explicit, formal, or informal, or just a collection of hunches or trends.

Whatever models are used in the forecasting process, whatever the degree of formalization, the results must, in the final analysis, be logical and defensible. Mathematics alone is just not acceptable in most cases, particularly in very involved social systems with potential political repercussions, so a dialogue is necessary.

Notice that in Figure 1 things get more uncertain the further they go into the future. The further one projects into the future, the greater is the risk that uncertain events can occur, and there will be less control. In fact, the amount of control may not be clear in any event. Someone may take control away from you. For example, one cannot realistically expect the plan for the next Administration to be the same as that used for the current Administration. It would appear that we must face the fact that the further we project into the future, the greater the number of possibilities for combinations there are, and the smaller the chances are for a forecast of what will happen to the planned degree of control.





DEAL WITH ISSUES NOT THE WHOLE SYSTEM ALL AT ONCE

BITE SIZED PIECES

INTERDEPENDENT ISSUES

FIGURE 1 Using data to build models that will assist in forecasting the impacts of alternative policy options to resolve current issues.

We are interested in the trends. We identify causal mechanisms from the trends if we can. Once identified, we can use these causal mechanisms in our models to try to understand the underlying phenomena. The causal mechanisms also lead us to the question of control. For the scientist or observer of the system, it is alright to build a model that has causal mechanisms in it, none of which can be manipulated. But for the engineer or politician, or for the individual interested in the way the world is headed, the question must eventually be asked: "Who has control, and how much control do they have?" "Is it control by a committee or by Congress?" "Is it absolute or partial?" There are very few political situations in which the control held by any one party is very large.

If systems are involved in the political arena, and most of the transport systems that we are discussing are very much involved in that arena, it is very important to deal with issues, not with the system all at once. The question raised several times here today is: How large do the models have to be, and how much data are required? I would suggest that the model should be as small as it can be and still answer the questions on the issue at hand.

One reason issues can be dealt with is that they are "bite-sized." They are pieces which Congress or other legislative bodies can deal with.

We do have the question of dealing with interdependent issues, and these issues are tough to handle. It takes the best effort that one can muster to deal with these interdependent issues. At times it helps to reformulate the issue at a higher level of hierarchy. If two issues are justifiably interdependent, they would eventually be considered jointly.

If planning starts with data, as has been suggested, then there will be a requirement to develop data bases. Each data base should be suited to the problems being addressed. A question that involves the whole national transportation system may need a national freight data base. On the other hand, if it is a regional or metropolitan problem, the size of the data base can be reduced. Here are some ways to build data bases from existing data sources. Figure 2 suggests the steps involved in making a spatially disaggregate data base.

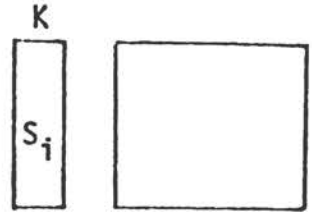
The first step is to identify sources of commodity production information by small areas. Information is presented in census publications at the county level. These county results can always be aggregated to get the areas that you are interested in. States or regions are merely aggregations of the county information.

Second, commodity production information and input-output coefficients may be used to develop commodity consumption by small area. Beginning with the lefthand vector, the next move is to develop the top vector. Third, transport price and level-of-service information is developed from point to point within the matrix. This produces the input required for the next step.

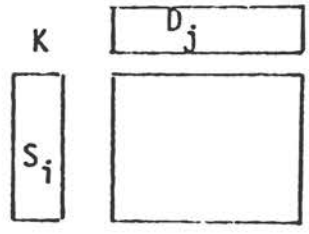
The fourth step involves use of freight demand models to obtain an initial distribution of commodity flows between origins and destinations. In other words, we fill out the matrix.

In the final step results are compared with the known margins. Thus,

1) IDENTIFY SOURCES OF COMMODITY PRODUCTION INFORMATION BY SMALL AREA (COUNTY BUSINESS PATTERNS, USDA UNLOADS, ETC.)

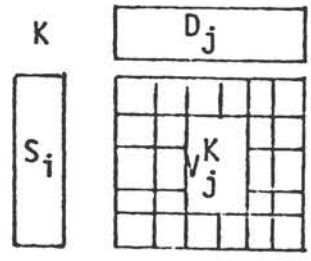


2) USE COMMODITY PRODUCTION INFORMATION AND I/O COEFFICIENTS TO DEVELOP COMMODITY CONSUMPTION INFORMATION BY SMALL AREA



3) DEVELOP TRANSPORT PRICE AND LEVEL OF SERVICE INFORMATION BY LANE

4) USE FREIGHT DEMAND MODELS TO OBTAIN INITIAL DISTRIBUTION OF COMMODITY FLOWS BETWEEN O/D'S



5) COMPARE RESULTS WITH KNOWN MARGINS, RESOLVE CONFLICTS, AND ADJUST RESULTS TO MATCH COMMODITY BY COMMODITY AND MODE BY MODE

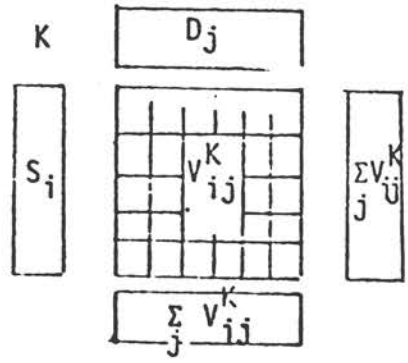


FIGURE 2 Developing a freight data base.

conflicts may be resolved and results adjusted to match commodity by commodity and mode by mode to the data that do exist.

I would like to divide the conclusions into two categories as a result of the kind of thinking about models and data that I have presented. The first category should be labeled research expectations, and the second one research needs. A large part of the research going on in the various universities, industrial firms, and government agencies is already making progress on developing some of the aspects in these two areas.

For research expectations:

1. Sampling methodology allows us to design an economical data collection process. Sampling theory has been around a long time, but we have used it too rarely with respect to the commodity information system.
2. Holding data in disaggregate form allows it to be used for a variety of end purposes by reaggregating it for each specific policy addressed. One data collection effort will frequently serve many ends by reaggregation.
3. A great deal of research has been directed to the development of disaggregate data to build disaggregate behavioral models that are policy-sensitive, efficient with respect to data needs, and can embody causal mechanisms correctly. Some of these models exist now, and they work very nicely for a variety of problems.
4. Disaggregate models can be used with aggregate control totals to investigate the results of any number of policy options. We can also use them to estimate elasticities, and we have talked several times during this conference about needing travel elasticities, and not having them. The development of such models is progressing, and we can look for them to be operational in the next year or so. When they do arrive, we will have a capability that we have never had before.
5. Aggregate data and census information already exist and can be used to extend the results of disaggregate models applied to a sample and to expand that result to give the totals for any particular situation. There is a large amount of this data, and it is all very specific even down to the county level.
6. Many problems require consideration of an area of interest that is less than the total system. An issue-oriented approach is necessary. I would argue that the use of sampling, with policy-sensitive disaggregate models and census data for expansion, is indeed an ideal way to go about studying limited issues. These techniques are all in the research pipeline now and will be coming out in the next year or so.

For research needs, it would be valuable:

1. To develop methods for connecting the aggregate macroeconomic forecasting models, previously discussed, to the sample-based disaggregate models that I have been describing here. We need data and models for transport level of service by mode. We need the capability to predict travel times, reliability and rates for any hypothetical shipment.

2. If we could develop a variety of small, special-purpose disaggregate surveys, the "hmm" surveys, to gather data of all kinds. These should be one time, focused surveys to get a particular piece of information.

3. To formulate better production functions for the various industries; that is, bigger input-output tables, etc.

4. To acquire information on how transport works, as well as how other industries function.

5. To develop better cost and rate information for the various modes, including cost models that show how changes in the system would impact the economic viability of the mode. It is going to be hard to work with any kind of a commodity system without knowing how the carriers are going to respond.

6. To understand possible futures, scenarios in other words, that could explain what could happen to us, how the economy will change in the future, how the population will grow, what the possibilities are for war, for obtaining needed energy, for return of the ice age, for the operations of the Third World, and so on.

I don't want to speculate on happenings that are too far-out, but it seems to me that Proxmire is right. We don't really need a DOT study in great detail on the return of the Ice Age. As Jerry Ward pointed out, most of these things can be perceived in time, and we don't really need great amounts of data to be able to deal with them.

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