ENERGY

SAN-1176-T5

MASTER

FUEL CONSERVATION OPPORTUNITIES THROUGH
CHANGES IN MODE OF FREIGHT TRANSPORTATION

Final Report

By
Richard M. Corbett
Albert E. Moon

June 1979

Work Performed Under Contract No. EY-76-C-03-1176

SRI International
Menlo Park, California

U. S. DEPARTMENT OF ENERGY

Division of Transportation Energy Conservation

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

DISCLAIMER

"This book was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof."

This report has been reproduced directly from the best available copy.

Available from the National Technical Information Service, U. S. Department of Commerce, Springfield, Virginia 22161.

Price: Paper Copy \$7.00
Microfiche \$3.50

FUEL CONSERVATION

**Opportunities Through
Changes in Mode of
Freight Transportation**

FINAL REPORT

June 1979

PREPARED BY

**Richard M. Corbett and Albert E. Moon
SRI International, Menlo Park, California**

Contract No. EY-76-C-03-1176

Prepared for:

**U. S. Department of Energy
Office of Transportation Programs
Washington, D. C. 20585**

ACKNOWLEDGMENTS

The authors wish to thank the corporate transportation officials who made adjustments in their busy schedules to provide us with the many ideas that we have analyzed and presented in this report. We also wish to express our appreciation to the vice president of marketing of a major U.S. railroad for his review of the draft of this report and for insightful comments on its content.

CONTENTS

ACKNOWLEDGMENTS	ii
LIST OF ILLUSTRATIONS	iv
LIST OF TABLES	iv
I INTRODUCTION	1
II EXECUTIVE SUMMARY	3
III IDENTIFICATION OF CANDIDATE SHIPPERS	6
Description of the Universe	7
Industry Sample Selection	10
IV INTERVIEWS WITH SHIPPERS	17
General Findings	19
Rail Performance	21
Railroad Attitudes	23
Rail Rate Increases	24
Rail Access	25
Car Design and Supply	26
Intermodal Service	27
Marketing	28
V RAILROAD IMPROVEMENT ALTERNATIVES	29
Rationalization of Crew Assignments in Terminal Yards	29
Rationalization of Train Departure Schedules	30
Rationalization of System Blocking to Bypass Inter- mediate Yards	30
Rationalization of Complex Terminal Areas	30
Door-to-Door Scheduling of Freight Movements	31
More Frequent Train Departures	31
VI HYPOTHETICAL CASE STUDIES	33
Identification of Case Studies	33
Transportation Alternatives	34
Cost and Energy Estimates	36
Railroad Cost Sensitivity	43
VII EVALUATION OF CASE STUDIES	44

ILLUSTRATIONS

1	Shipper Interview Format	20

TABLES

1	Outbound Tonnage Generated by Manufacturing Establishments: 1972	8
2	Modal Characteristics of Manufacturing Production	9
3	Surface Common Carrier Modal Split at Manufacturing Plants	11
4	Distribution of Surface Common Carrier Tonnage by Commodity Group	12
5	Categories of Shippers According to Volume and Modal Split Preferences	13
6	Characteristics of Production by Manufacturing Plants by Category	14
7	Commodities for Modal Shift Analysis	16
8	Modal Characteristics of Commodities Produced by Shipper Respondents	18
9	General Characteristics of Case Studies	35
10	Case Study 1: Aluminum Products Shipped in Low Volumes over Long Distances	37
11	Case Study 2: Canned Foods Shipped in Medium Volumes over Long Distances	38
12	Case Study 3: Automotive Parts Shipped in Low Volumes over Long Distances	39
13	Case Study 4: Steel Products Shipped in Medium Volumes over Short Distances	40
14	Case Study 5: Industrial Chemicals Shipped in Very High Volumes over Short Distances	41
15	Case Study 6: Packaged Foods Shipped in High Volumes over Short Distances	42
16	Selected Transportation Characteristics of Case Study Operations	45

17	Estimates of National Cost and Energy Savings Resulting from Shifts to Rail for Selected Commodities	46
18	Estimates of Cost and Energy Savings Resulting from Total Shift of Sensitive Traffic from Truck to Rail	47

I INTRODUCTION

The average fuel consumed to move freight by railroad is about one-fourth the fuel required to move an equivalent weight of goods over the same distance by motor carrier. Thus, it would appear that shifting freight transport from highways to railroads would conserve significant amounts of petroleum fuel. There are at least two difficulties with this oversimplified view, however: (1) The service characteristics of the two modes are quite different for some locations and commodities; and (2) the energy required to move a particular commodity between specified origin-destination points varies over a range of about 1 to 3. Thus, economical approaches to energy conservation from changes in mode of shipment require that cost and service characteristics of the railroad be competitive with motor carriage and that, under the conditions where the service is competitive, the fuel consumption characteristics of the shipment favor the railroad mode.

Measured by freight ton-miles, railroads served 36% of the intercity freight market in 1977, compared with about 24% for trucks.* The railroad share of the intercity freight market has declined from over 50% over the past 20 years and continues to decline. In part, the decline results from changes in the mix of goods transported--from bulk materials, where railroads predominate, to more highly manufactured goods, where the highway carriers have service advantages.

Another reason for the decline in the railroads' share of the intercity freight market was the deterioration of the railroad system while the interstate highway system was being constructed. The interstate highway system increased productivity and decreased the cost of highway transportation. The deterioration of the railroad system reduced the productivity and increased the costs of railroad service. Can anything be done to reverse the loss of market share for the railroads in the face of shortages of petroleum fuel that point to increased use of railroads as a conservation opportunity?

In past years, railroads have staged dramatic comebacks in market share. Notable among the success of railroads in recapturing lost traffic is the carriage of automobiles. In the early 1950s almost all automobiles were transported by motor carrier to all U.S. destinations. The railroads, working with the shippers, developed multilevel racks with high capacity that provided an opportunity for hauling a larger number of vehicles per car, thus reducing unit costs, and coupled this equipment development with

---

* Association of American Railroads, Yearbook of Railroad Facts, Washington, D.C. (1978).

premium service and a competitive, although higher than before, rate structure. By the late 1950s most automobile transport returned to the railroads. Transportation of automobile parts to assembly plants in specialized boxcars followed a similar pattern.

An SRI International project team, under contract to the U.S. Department of Energy, undertook a study to identify opportunities for and barriers to increased use of railroads to promote fuel conservation. The project team recognized that trucking service is more economical than railroads for many commodities, despite lower freight ton-mile rates for the rail mode, because storage and handling costs associated with truck transportation are lower than those associated with railroad transportation. To identify the competitive traffic, the project team interviewed a limited number of high-volume shippers selected from industries where a combination of railroad and highway transportation is used. Earlier contacts with some of these shippers indicated that personnel in their traffic organizations were very knowledgeable about railroad and highway problems and opportunities. Some of these shippers had even expended considerable effort in constructing their own transportation systems.

II EXECUTIVE SUMMARY

The project team interviewed transportation officials from nine companies in the processed food, metals, chemicals, and transportation vehicles industries. These industry personnel identified unreliable delivery times and equipment shortages as the key issues in their decision not to use the railroads. Two factors were identified that make the outlook for an increased railroad market share unpromising: (1) conversion of distribution facilities from railroad to highway orientation, and (2) the location of new plants where there is no railroad access. Companies that reorganized their distribution system around trucking cite the general decline of railroad service over the past few years, aggravated by the problems encountered during the winter storms of 1977 and 1978. A shift of manufacturing facilities to more southerly parts of the United States has resulted in plant locations away from railroad access.

Shippers attribute delivery time unreliability to yards in major terminal areas and to congestion in large gateway areas. They suggest various methods of avoiding delays by routing directly to the yard serving the plant. Trailer-on-flatcar (TOFC) or container-on-flatcar (COFC) service appears attractive to many because of the ability to avoid the succession of yard moves in terminal areas.

Equipment shortages can be traced in large measure to reduced standards for transit time and transit time reliability. As delivery times become longer, the turnaround, or car cycle, time becomes longer, resulting in a reduction in the number of units available for use.

The SRI project team has identified a range of actions that railroad management could take to improve transit time reliability. Barriers to implementing changes include (in increasing order of difficulty) changes in operating practices, capital outlays, increased operating costs, and changes in work rules. Ranked by increasing order of difficulty to implement, actions to improve reliability are as follows:

- Rationalize train schedules
- Rationalize yard crew assignments in terminal areas
- Rationalize system blocking plan
- Rationalize configuration of complex terminal areas
- Schedule freight cars from door to door
- Operate freight trains more frequently.

Train departure schedules can be rationalized by allowing time for an incoming car to be switched and placed on its outbound connecting train and by increasing emphasis on departing on schedule. Yard crew assignments in terminal areas can be adjusted to avoid having traffic wait in subordinate terminal yards because of lack of crew assignments. Rearranging blocking to avoid classification operations will save transit time and reduce transit time unreliability. Rearrangement of traffic flows in major terminal and gateway areas can eliminate intraterminal moves and thus save additional time. Scheduling of freight cars from door to door will allow both railroads and shippers to maintain control over the movement, identifying deviations from the plan, and speed the application of remedial action. Operation of more frequent trains will minimize the effect of missed connections and permit the bypass of intermediate points. Because the more frequent train is shorter, it can also be more specialized.

One shipping officer identified improved railroad marketing as a prerequisite for capturing increased railroad market share. He cited the need for a coordinated package of rates, equipment, and service which he could evaluate in terms of his own needs. He contrasted this with the current practice of having to deal with several different railroad personnel at different times to negotiate rates, equipment, and service. He noted little apparent relationship on the railroad side concerning these factors.

Many of the other remarks made by shippers could be interpreted as pleas for improved railroad marketing. The capture of additional freight traffic market share is a classical marketing problem of coordinating the product, price, selling, and delivery system to the needs of the customers. The success of the recapture of automobile transportation can be interpreted in terms of a marketing package.

Our analysis leads us to conclude that marketing railroad freight transportation does not involve selling a ubiquitous railroad service but rather concentrating and coordinating improvements between a few pairs of points of service at a time. By building volume between specific pairs, more direct blocking and train service can be achieved, thus improving service further. However, these lane improvements cannot be achieved at the expense of other services that are offered, since many large shippers use the railroad between several different points of service. Overall service levels must also be maintained to speed car movement and maintain car supply.

Our analysis also indicates that specialized trains or service may be needed to convince skeptical users that they are getting improved service. By clearly identifying the service, it will be readily apparent to the user that his service is, or is not, being provided. Furthermore, the performance of the improved service can be readily measured. One of the attractions of TOFC/COFC service is that it is clearly identifiable and distinguishable from other railroad services.

There have been railroad marketing successes since the railroads regained automobile traffic in the late 1950s. The shippers we interviewed provided us with several examples of railroad services that explicitly fit their needs. The project team constructed hypothetical shipments to illustrate these services but moved the origins and destinations to other locations to protect the confidences of the shippers interviewed. These shipments retain the initial characteristics of volume, distance, shipment size, and commodity. Our analysis using the SRI Long-Run Average Cost and Energy Model shows that significant fuel savings are achieved with these shipments under conditions where truck carriage is very competitive.

The analysis shows that railroads predominate in the longer-distance larger-shipment business, and highway carriers hold most of the short-distance and small-shipment business. The middle ground between these extremes is the competitive range that is sensitive to marketing and other efforts by railroads to increase their market share.

The shipments analyzed are in the competitive range of shipment sizes and distances. The evaluation of these shipments shows that for each 1% of shift from truck to railroad of only the competitive shipment sizes and distances, about 0.5 million gal of fuel would be saved for the six commodities studied. If all of the traffic in the competitive range were shifted from truck to railroad, about 18 million gal of fuel would be saved, the equivalent of about one day's consumption for the entire nation.

III IDENTIFICATION OF CANDIDATE SHIPPERS

The project team generated a list of shippers whose distribution activities might be selectively examined to investigate the extent of potential shifts in their traffic from the truck to the rail mode.

The set of shippers to be identified was intended to correspond to a number of controlling factors and yet to exhibit certain other descriptive characteristics. The deterministic framework was designed to ensure that:

- Shippers selected were large-volume shippers with varied distribution activities and extensive knowledge of distribution alternatives. These shippers should have their products marketed nationwide.
- Shippers selected had available to them and utilized both rail and truck services. Shippers that were largely captive truck or rail users because of location or product handling characteristics would not be considered in the initial survey.
- Shippers selected should exhibit some descriptive representativeness in terms of geographic and product mix balance.

Given the limited and restrictive scope of the selection process, no attempts were made to ensure randomness or statistical consistency in the sample. Nevertheless, it was considered important for the approach to be systematic. Therefore, a hierarchical procedure was developed that would:

- Permit factoring of the sample to the universe.
- Permit adjustment of the selection criteria in order to contract or expand the sample, particularly as the analysis proceeded.
- Ensure nondiscriminatory sample selection.

The limited approach argued for an emphasis in sampling that would enable maximum benefit. For this reason, the analysis was directed toward industries whose volume of shipments was large and tended to be concentrated in large plants. Furthermore, considerably more emphasis was placed on examining industries that used common carrier trucks as opposed to private trucking. These actions do not imply any level of importance for these characteristics but rather were an attempt to keep the study within manageable proportions.

Description of the Universe

The 1972 Census of Transportation's "Commodity Transportation Survey" provided the basis for the description of the universe and the selection of an industry sample. The census describes, for 24 commodity groups that are aggregated from Standard Industrial Classification (SIC) codes, various shipper characteristics, such as amounts shipped by transportation modes, plant size, and distance of shipments, all presented in tons and ton-miles. Other volumes in this survey describe commodity transportation characteristics by individual SIC code, although the range of descriptors is more limited. The Census of Transportation data are compatible with the Census of Manufactures and the rail Carload Waybill Statistics, all of which use the SIC base. The limitations of the Census of Transportation data generally meant a fairly limited application of results, however.

The tonnage generated by manufacturing plants in 1972 is highlighted in Table 1.* The Census of Transportation's exclusion of plants with fewer than 20 employees and industries that serve local markets is reflected in the table, where data are presented for all plants and for large plants. The latter (those with 500 or more employees) account for 43.5% of all traffic.

Table 1 shows that five of the commodity groups account for less than 1% of total nonfuel tonnage by all carriers. The largest industries include, for all plants, stone and glass, prepared foods, and iron and steel; for large plants, this list is supplanted by iron and steel, motor vehicles, and basic chemicals. A high proportion of production is concentrated in large plants for those industries whose products are more highly manufactured.

Table 2 describes manufacturing tonnage according to modal characteristics, noting the absolute and percentage tonnage in plants accounted for by surface common carriers (rail and common carrier trucking) as well as the percentage of tonnage carried in private trucks. Private trucking accounts for 21.3% of nonfuel tonnage in all plants but is particularly high for foods and wood products commodities. In large plants, private trucking is greatly reduced, in tandem with a reduction in short hauls. About seven eighths of nonfuel tonnage in large plants is carried by rail and common carrier trucking. Whereas large plants account for 38.2% of total tonnage by all modes, they contribute 44.8% of all common carrier tonnage.

The proportion of total distribution undertaken in private trucks corresponds closely to the proportion of shipments under 100 miles--distances under which rail transportation is usually not cost or service competitive. Furthermore, although private trucking at large plants is

---

*Table 1 and subsequent tables exclude tonnage in the fuels category. This category includes coal and oil, is distinctive in all respects, and was not considered for shipper selection purposes.

Table 1 Outbound Tonnage Generated by Manufacturing Establishments, 1972 (tonnages in thousands)

COMMODITY GROUP	ALL PLANTS		LARGE PLANTS		Percentage of Total Production in Large Plants
	Total Tonnage All Carriers	Percentage of Total	Total Tonnage All Carriers	Percentage of Total	
1. Meat and Dairy Products	42,616	3.8	13,990	3.2	32.8
2. Prepared Foods	154,015	13.6	27,206	6.3	17.7
3. Beverages	57,996	5.1	15,596	3.6	26.9
4. Textiles	14,209	1.3	5,922	1.4	41.7
5. Apparel	5,798	0.5	1,674	0.4	28.9
6. Paper	89,410	7.9	40,676	9.4	45.5
7. Basic Chemicals	111,853	9.8	44,765	10.3	40.0
8. Other Chemicals	58,902	5.2	12,314	2.8	20.9
10. Rubber and Plastics	15,877	1.4	8,351	1.9	52.6
11. Lumber	79,991	7.0	9,274	2.1	11.6
12. Furniture	14,371	1.3	3,782	0.9	26.3
13. Stone and Glass	178,122	15.7	20,182	4.7	11.3
14. Iron and Steel	139,461	12.3	117,085	27.0	84.0
15. Nonferrous Metals	29,954	2.6	15,972	3.7	53.3
16. Fabricated Metals	14,370	1.3	4,741	1.1	31.9
17. Other Metal Products	23,595	2.1	10,331	2.4	43.6
18. Industrial Machinery	8,599	0.8	2,939	0.7	33.8
19. Other Machinery	16,222	1.4	10,139	2.3	62.5
20. Communications Equipment	2,327	0.2	1,714	0.4	73.7
21. Electrical Products	13,131	1.2	9,449	2.2	72.0
22. Motor Vehicles	56,716	5.0	55,039	12.7	97.0
23. Other Transport Equipment	6,506	0.6	1,763	0.4	27.1
24. Instruments	1,603	0.1	1,047	0.2	65.3
NON-FUEL COMMODITY GROUPS	1,136,355	100.2	433,962	100.1	38.2
9. Fuels	348,137	(30.6)	212,045	(48.9)	60.9
ALL COMMODITY GROUPS	1,484,492	(130.6)	646,007	(148.9)	43.5

Source: Census of Transportation, 1972

Table 2 Modal Characteristics of Manufacturing Production (tonnages in thousands)

COMMODITY GROUP	ALL PLANTS				LARGE PLANTS			
	Total Tonnage By		Percentage of Total Tonnage By		Total Tonnage By		Percentage of Total Tonnage By	
	All Carriers	Common Carriers	Private Truck	Common Carriers	All Carriers	Common Carriers	Private Truck	Common Carriers
1. Meat and Dairy Products	42,616	25,783	39.1	60.5	13,990	9,038	35.1	64.6
2. Prepared Foods	154,015	109,351	23.0	71.0	27,206	24,186	9.3	88.9
3. Beverages	57,996	23,836	58.4	41.1	15,596	9,857	35.9	63.2
4. Textiles	14,209	10,103	27.7	71.1	5,922	4,199	28.0	70.9
5. Apparel	5,798	4,517	15.6	77.9	1,674	1,408	11.7	84.1
6. Paper	89,410	71,260	17.9	79.7	10,676	38,073	4.3	93.6
7. Basic Chemicals	111,853	88,028	12.1	78.7	14,765	37,692	5.0	84.2
8. Other Chemicals	58,902	45,001	15.7	76.4	12,314	11,206	7.5	91.0
10. Rubber and Plastics	15,877	13,257	15.2	83.5	8,351	7,424	10.3	88.9
11. Lumber	79,991	45,594	36.3	62.0	9,274	7,725	15.0	83.3
12. Furniture	14,371	5,111	34.7	63.4	3,782	3,184	14.9	84.2
13. Stone and Glass	178,122	125,082	23.7	69.1	20,182	13,966	15.4	69.2
14. Iron and Steel	139,461	122,865	6.7	88.1	117,085	104,791	5.0	89.5
15. Nonferrous Metals	29,954	24,862	15.1	83.0	15,972	14,471	7.3	90.6
16. Fabricated Metals	14,870	10,796	25.1	72.6	4,741	3,940	11.2	83.1
17. Other Metal Products	23,695	19,169	17.8	80.9	10,331	9,577	6.3	92.7
18. Industrial Machinery	8,699	6,872	18.9	79.0	2,939	2,495	12.3	84.9
19. Other Machinery	16,222	12,961	17.7	79.9	10,139	8,861	10.3	87.4
20. Communications Equipment	2,327	1,803	12.4	77.5	1,714	1,397	11.0	81.5
21. Electrical Products	13,131	11,069	14.1	84.3	9,449	8,211	12.3	86.9
22. Motor Vehicles	56,716	54,788	3.0	96.6	55,039	53,553	2.3	97.3
23. Other Transport Equipment	6,506	2,824	54.8	43.4	1,763	1,569	9.1	89.0
24. Instruments	1,603	1,358	10.9	84.7	1,047	911	9.7	87.0
NON-FUEL COMMODITY GROUPS	1,136,355	842,290	21.3	74.1	133,962	377,734	8.8	87.0
9. Fuels	348,137	89,471	8.4	25.7	212,045	39,440	5.4	18.6
ALL COMMODITY GROUPS	1,484,492	931,761	18.3	62.8	546,007	417,174	7.7	64.6

Source: Census of Transportation, 1972

only 8.8% of total distribution, more than one quarter of that tonnage is from the meats and beverages industries, where private trucking is relatively important. Private trucking has been excluded from extensive analysis primarily because of its correspondence with short-haul shipments. Nevertheless, long-haul shipments in private trucks are considered prime candidates from which rail might shift traffic if service or other rail improvements were made. The lack of descriptive data of this sector does not contribute, however, to its direct analysis here. Where reference is made later to trucks, it assumes common carrier vehicles only.

The modal split between rail and motor carriers is presented in Table 3. In large plants, rail carries 56.1% of outbound tonnage, although the proportion varies extensively by shipper group. Shippers that appear captive to truck include textiles and apparel, industrial machinery, and communications equipment. The rail captives consist of paper and lumber. Table 4 shows the distribution of total common carrier tonnage by commodity group. More than one quarter of large-plant tonnage is accounted for by iron and steel, with lesser contributions by motor vehicles, paper, and basic chemicals.

Industry Sample Selection

Given the shipper characteristics introduced above, it was possible to define the sample of industries from which individual shippers could be selected. Table 5 stratifies shipper groups according to modal split differences and volume of shipments. Five commodity groups in Category E that individually contribute less than 2% of total tonnage were not considered candidates for selection because they are too small to contribute substantially to an explanation of ship behavior in the universe. The five groups comprise less than 4.7% of all tonnage in all plants and are even less important to common carrier or large-plant tonnage. Commodities that are otherwise sufficiently large for analysis but exhibit pronounced rail preference are described in Category F. This category consists of paper and lumber; although it comprises 15% of tonnage, it uses rail 80% of the time. Category D includes four commodity groups that exhibit pronounced truck preference and are also low in volume.

Categories A through C in Table 5 describe industries according to their modal split preferences. These groups, in aggregate, comprise almost 80% of total tonnage. Table 6 further describes shipper characteristics. The sample of industries in Categories A through C produce 59.5% of all U.S. tonnage. The tonnage on common carriers at large plants amounts to 20.6% of all tonnage.

The different commodities produced within each of the 12 commodity groups noted in Table 5 are quite extensive. The modal split and volume characteristics of the individual commodity classifications were further examined. Data related to plant size were not available for this exercise. Commodities described as "miscellaneous"--those with less than 1% of total production of the groups in Categories A through C and those

Table 3 Surface Common Carrier Modal Split at Manufacturing Plants (tonnages in thousands)

COMMODITY GROUP	ALL PLANTS			LARGE PLANTS		
	Surface Common Carrier Tonnage			Surface Common Carrier Tonnage		
	Rail	Motor	Modal Split	Rail	Motor	Modal Split
1. Meat and Dairy Products	8,012	17,771	31.1	3,022	6,016	33.4
2. Prepared Foods	78,086	31,265	71.4	16,378	7,808	67.7
3. Beverages	8,931	14,905	37.5	4,476	5,381	45.4
4. Textiles	1,378	8,724	13.7	764	3,435	18.2
5. Apparel	493	4,024	10.9	275	1,133	19.5
6. Paper	46,225	25,035	64.9	29,327	8,745	77.0
7. Basic Chemicals	54,361	33,668	61.8	24,352	13,340	64.6
8. Other Chemicals	22,265	22,736	49.5	5,948	5,258	53.1
10. Rubber and Plastics	3,874	9,383	29.2	2,990	4,434	40.3
11. Lumber	36,636	12,959	73.9	6,751	974	87.4
12. Furniture	3,162	5,950	34.7	1,577	1,607	49.5
13. Stone and Glass	39,009	84,074	31.7	4,319	9,647	30.9
14. Iron and Steel	60,944	61,921	49.6	51,283	53,508	48.9
15. Nonferrous Metals	15,456	9,406	62.2	8,817	5,654	60.9
16. Fabricated Metals	2,573	8,223	23.8	1,759	2,181	44.6
17. Other Metal Products	8,720	10,449	45.5	6,767	2,810	70.7
18. Industrial Machinery	1,705	5,167	24.8	411	2,084	16.5
19. Other Machinery	4,299	8,663	33.2	3,751	5,110	42.3
20. Communications Equipment	303	1,501	16.8	293	1,104	21.0
21. Electrical Products	4,596	6,474	41.5	4,205	4,006	51.2
22. Motor Vehicles	33,633	21,155	61.4	33,299	20,254	62.2
23. Other Transport Equipment	1,269	1,555	44.9	917	652	58.4
24. Instruments	335	1,023	24.6	290	621	31.8
NON-FUEL COMMODITY GROUPS	436,815	405,975	51.9	211,773	166,108	56.1
9. Fuels	33,769	55,702	37.7	20,144	19,296	51.1
ALL COMMODITY GROUPS	470,584	461,677	50.5	231,917	185,404	55.6

Source: Census of Transportation, 1972

Table 4

DISTRIBUTION OF SURFACE COMMON CARRIER TONNAGE BY COMMODITY GROUP
(Tonnages in Thousands)

Commodity group	Surface Common Carrier Tonnage (percentage of total production)	
	<u>All Plants</u>	<u>Large Plants</u>
Meat and dairy products	3.1	2.4
Prepared foods	13.0	6.4
Beverages	2.8	2.6
Textiles	1.2	1.1
Apparel	0.5	0.4
Paper	8.5	10.1
Basic chemicals	10.5	10.0
Other chemicals	5.3	3.0
Rubber and plastics	1.6	2.0
Lumber	5.9	2.0
Furniture	1.1	0.8
Stone and glass	14.6	3.7
Iron and steel	14.6	27.7
Nonferrous metals	3.0	3.8
Fabricated metals	1.3	1.0
Other metal products	2.3	2.5
Industrial machinery	0.8	0.7
Other machinery	1.5	2.3
Communications equipment	0.2	0.4
Electrical products	1.3	2.2
Motor vehicles	6.5	14.2
Other transport equipment	0.3	0.4
Instruments	0.2	0.2
Nonfuel commodity groups	100.1	99.9
Fuels	(10.6)	(10.4)
All commodity groups	(110.6)	(110.4)

Source: Census of Transportation, "Commodity Transportation Survey" (1972)

Table 5

CATEGORIES OF SHIPPERS ACCORDING TO VOLUME AND MODAL SPLIT PREFERENCES

Commodity Group	Percentage of Total Tonnage of All Commodities in All Plants		Rail Modal Split of Sur- face Common Carrier Tonnage	
	All Modes	Surface Common Carriers	All Plants	Large Plants
A. Competitive modal split (45-55%)*				
Beverages	5.1	2.8	37.5	45.4
Other chemicals	5.2	5.3	49.5	53.1
Iron and steel	12.3	14.6	49.6	48.9
Electrical products	<u>1.2</u>	<u>1.3</u>	<u>41.5</u>	<u>51.2</u>
Subtotal	23.7	24.1	47.7	49.2
B. Truck-oriented modal split (25-45%)				
Meat and dairy	3.8	3.1	31.1	33.4
Stone and glass	15.7	14.6	31.7	30.9
Other machinery	<u>1.4</u>	<u>1.5</u>	<u>33.2</u>	<u>21.0</u>
Subtotal	20.9	19.2	31.7	34.8
C. Rail-oriented modal split (55-75%)				
Prepared foods	13.6	13.0	71.4	67.7
Basic chemicals	9.8	10.5	61.8	64.6
Nonferrous metals	2.6	3.0	62.2	60.9
Other metal products	2.1	2.3	45.5	70.7
Motor vehicles	<u>5.0</u>	<u>6.5</u>	<u>61.4</u>	<u>62.2</u>
Subtotal	33.1	35.2	64.2	64.2
Total Categories A-C	77.7	78.5	51.2	54.6
D. Commodities with less than 2% of traffic and abnormal modal split				
Textiles	1.3	1.2	13.7	18.2
Apparel	0.5	0.5	10.9	19.5
Industrial machinery	0.8	0.8	24.8	16.5
Communications equipment	<u>0.2</u>	<u>0.2</u>	<u>16.8</u>	<u>21.0</u>
Subtotal	2.7	2.8	16.7	18.3
E. Commodities with less than 2% of traffic only				
Rubber and plastics	1.4	1.6	29.2	40.3
Furniture	1.3	1.1	34.7	49.5
Fabricated materials	1.3	1.3	23.8	44.6
Other transport equipment	0.6	0.3	44.9	58.4
Instruments	<u>0.1</u>	<u>0.2</u>	<u>24.6</u>	<u>31.8</u>
Subtotal	4.7	4.4	30.0	44.2
F. Commodities with abnormal modal split				
Paper	7.9	8.5	64.9	77.0
Lumber	<u>7.0</u>	<u>5.9</u>	<u>73.9</u>	<u>87.4</u>
Subtotal	14.9	14.3	68.6	78.8
Total Categories D-F	22.3	21.5	54.0	62.7

* At large plants.

Table 6

Characteristics of Production by Manufacturing Plants by Category (tonnages in thousands)

<u>CHARACTERISTIC</u>		<u>NATIONAL TOTAL</u>	<u>GROUP A</u>	<u>GROUP B</u>	<u>GROUP C</u>	<u>GROUPS A-C</u>	<u>GROUPS D-F</u>	<u>FUELS</u>
1. All Plants, All Transport Modes								
a. Tonnage		1,484,481	269,490	236,960	376,233	882,683	253,661	348,137
Percentage		100.0	18.2	16.0	25.3	59.5	17.1	23.5
b. Ton-miles		631,058	83,447	61,486	166,025	310,958	127,747	192,353
Percentage		100.0	13.2	9.7	26.3	49.3	20.2	30.5
c. Average trip length		425	310	259	441	352	504	553
2. All Plants, Surface Common Carriers								
a. Tonnage		931,761	202,771	161,826	296,198	660,795	181,495	89,471
Percentage		100.0	21.8	17.4	31.8	70.9	19.5	9.6
Percentage of all modes (1a)		62.8	13.7	10.9	20.0	44.5	12.2	6.0
b. Ton-miles		396,935	68,369	50,927	146,495	265,791	109,408	21,736
Percentage		100.0	17.2	12.8	36.9	67.0	27.6	5.5
Percentage of all modes (1b)		62.9	10.8	8.1	23.2	42.1	17.3	3.4
c. Average trip length		426	337	315	495	402	603	243
3. Large Plants, Surface Common Carriers								
a. Tonnage		417,174	134,065	31,865	139,479	305,409	72,325	39,440
Percentage		100.0	32.1	7.6	33.4	73.2	17.3	9.5
Percentage of all plants (1a)		28.1	9.0	2.1	9.4	20.6	4.9	2.7
b. Ton-miles		193,622	44,520	16,103	75,676	136,299	45,480	11,843
Percentage		100.0	23.0	8.3	39.1	70.4	23.5	6.1
Percentage of all plants (1b)		30.7	7.1	2.6	12.0	21.6	7.2	1.9
c. Average trip length		464	332	505	543	446	629	300

Source: Census of Transportation, 1972

that exhibited abnormal preference in modal split--were excluded from the sample. At the conclusion of the exercise, 18 commodities were considered suitable for selection. Table 7 presents this list by commodity group and SIC number. These commodities account for 65.1% of the total tonnage by all modes in Categories A through C and 50.6% of all tonnage of all nonfuel commodities.

From corporate directories, a selected set of large manufacturers of these commodities was prepared. These manufacturers were considered suitable candidates for further study in later tasks and were representative of the shippers whose distribution activities were of interest.

Table 7

COMMODITIES FOR MODAL SHIFT ANALYSIS
(Tonnages in Thousands)

Commodity group	Standard Industrial Classification Number	Tonnage	Percentage of Total	Rail/ Highway Modal Split
Beverages	208	49,528	5.6	43.7
Soaps	284	11,732	1.3	29.9
Agricultural chemicals	287	26,422	3.0	69.2
Mill and rolled steel products	331	114,167	12.9	48.6
Iron castings	332	12,283	1.4	29.7
Electrical transmission equipment	361	14,884	1.7	36.3
Meats	201	31,417	3.6	29.7
Dairy products	202	10,237	1.2	35.8
Clay	325	19,788	2.2	38.0
Concrete, gypsum	327	41,717	4.7	26.0
Abrasives, asbestos	329	20,680	2.3	63.7
Canned foods	203	34,318	3.9	45.7
Sugar	206	11,788	1.3	56.7
Industrial chemicals	281	79,279	9.0	62.7
Plastics	282	24,427	2.8	50.5
Copper, aluminum shapes	335	17,162	1.9	48.5
Motor vehicles	3711	38,997	4.4	58.1
Motor vehicle parts	3714	15,711	1.8	65.4
Total		574,537	65.1	--
Total major commodity groups		882,683	100.0	--

Source: Census of Transportation, "Commodity Transportation Survey" (1972)

IV INTERVIEWS WITH SHIPPERS

Based on the analysis of Census of Transportation data described in Section III, 18 sizeable industries were identified which were not captive to either rail or truck transportation services. These industries include chemicals, foods, motor vehicles, and some refined metals manufacturing.

Candidate manufacturers of these products were identified from manufacturing directories. There was a clear objective to identify major shippers whose transportation and distribution activities were expected to exhibit a wide range of relevant characteristics and whose knowledge of promising logistics opportunities might be more acute. Few of these manufacturers were headquartered in the southeast, southwest, or in the mountain states.

Three rounds of interviews with traffic personnel in some of these industries were launched. Major commodities produced by the shippers interviewed included:

- Canned and packaged foods and beverages
- Sugar
- Aluminum
- Steel
- Agricultural and industrial chemicals
- Motor vehicles
- Motor vehicle parts.

Collectively, these commodities generate almost two fifths of all U.S. nonfuel tonnage that does not exhibit strong modal preference. Table 8 describes these commodities in detail according to their modal characteristics.

Senior personnel responsible for distribution at these firms--generally traffic managers--were contacted and interviews were requested. For the first two rounds, interviews were restricted to firms based on the east and west coasts, although most distributed their products nationally. Companies operating from the midwest were the subject of the third round of interviews.

The objective of the interviews was to solicit ideas, borne out of shippers' experience with rail service, that might bring about a shift of some traffic in manufactured goods from truck to rail. Despite fairly specific objectives, the means of encouraging such responses were less clear. As the interview process progressed, the areas of investigative

TABLE 8

Modal Characteristics of Commodities Produced
by Shipper Respondents

Commodity	Tonnage	Ton-Miles	Length of Haul	Total Modal Split*			Rail/Truck Modal Split	Percentage of Total non- Fuels Tonnage not modally captive
				Rail	Common Truck	Private Truck		
2025 Cheese	3,294	1,650	501	19.5	43.2	37.2	31.1	0.4
2033 Canned foods	15,539	8,700	560	33.1	37.9	28.1	46.6	1.8
2037 Frozen foods	3,689	3,594	974	38.8	49.9	10.9	43.7	0.4
2062 Sugar	10,045	4,728	471	44.3	37.1	15.1	54.4	1.1
2084 Wine	2,092	1,797	859	35.0	50.6	13.2	40.9	0.2
2095 Coffee	1,329	640	482	21.4	67.9	10.1	24.0	0.2
2096 Margarine	4,617	1,810	392	33.6	44.2	21.9	43.2	0.5
FOODS	40,605	22,919	564	35.1	41.6	22.0	45.8	4.6
2812 Inorganic Chemicals	18,148	4,869	268	61.9	23.2	9.2	72.7	2.1
2818 Organic Chemicals	23,660	12,648	535	40.7	26.0	4.8	51.0	2.7
2819 Other Chemicals	26,253	10,207	389	42.6	31.4	9.0	57.6	3.0
2821 Plastics	24,427	13,902	569	44.6	43.8	8.3	50.5	2.8
2871 Fertilizers	24,345	6,313	259	58.1	23.4	12.9	71.3	2.8
CHEMICALS	116,833	47,939	410	48.9	25.3	8.8	65.9	13.2
3312 Primary Iron and Steel	134,425	28,803	276	44.0	47.5	4.0	48.1	11.8
IRON AND STEEL	134,425	28,803	276	44.0	47.5	4.0	48.1	11.8
3334 Primary Aluminum	17,162	2,517	147	35.5	37.7	25.9	48.5	1.9
3352 Aluminum Shapes	4,209	2,116	503	23.6	57.2	18.7	29.2	0.5
ALUMINUM	21,371	4,633	216	33.2	41.5	24.5	44.4	2.4
3711 Motor Vehicles	38,997	23,576	605	57.9	41.7	0.4	58.1	4.4
3714 Motor Vehicle Parts	15,711	7,000	446	58.9	31.2	9.1	65.3	1.8
3715 Truck Trailers	527	222	421	11.3	51.3	37.1	18.1	0.1
MOTOR VEHICLES	55,235	30,798	557	57.7	38.8	3.2	59.8	6.3
ALL ABOVE COMMODITIES	338,469	135,092	399	46.2	37.3	9.0	55.3	38.3
All Non-Fuels commodities not modally captive	882,683	310,958	352	38.4	36.6	21.6	51.1	100.0

* Based on tonnage

SOURCE: Census of Transportation, 1972

interest became more refined and, consequently, the interview approach as well. Generally, manufacturers were encouraged to describe their ideas in their own way. Nevertheless, to bolster the process, a continually evolving structured format was developed, a late version of which is highlighted in Figure 1.

General Findings

There was, not surprisingly, a regional perspective to shipper operations and problems that bridged product differences. Shippers in California served their west coast markets almost exclusively by truck; they reached their eastern and midwest markets by rail, using conventional box-car service. Benefiting from the strength of the western railroads, California shippers noted fewer problems with rail service than shippers elsewhere. On the other hand, eastern shippers interviewed suffered extensively from long railroad transit times, car shortages, and service interruptions. Strong trends toward truck usage were evidenced by eastern shippers, despite increased costs.

Midwest producers related experiences with rail service that occupied a middle ground between the rather good service provided western shippers and the rather poor service provided those in the northeast. Midwest producers were, on the other hand, among the largest of those interviewed, and their rail experiences more often than not reflected volume-related problems. Midwestern manufacturers were more able to cope and overcome rail problems than their eastern counterparts.

Despite an essentially common set of rail problems, the positive and negative experiences of most manufacturers were unique. All faced problems of equipment shortages and travel time unreliability, usually on account of terminal delays. Many considered rail their most practical transportation means, yet most saw an erosion of the rail proportion of their traffic. Despite their awareness of the current rail environment and their recognition of the operating difficulties it fosters, shippers from coast to coast believed that rail could recapture certain traffic segments provided a reliable transportation package were offered.

Despite an often gloomy assessment by shippers of rail's current ability to perform and compete efficiently, the same shippers were usually optimistic about rail's potential to do so, particularly for high-volume traffic. In the limited number of circumstances where shippers described aggressive railroad efforts to recapture their traffic, these efforts were widely applauded. There is evidence of a "latent" goodwill on the part of many shippers.

That shippers see some promise in rail's ability to compete should not disguise, however, a rather sorry state of affairs in terms of modal split. Although the shippers selected for interviews represented industries in which rail was nationally competitive (i.e., held at least 25% of the market), the rail proportion of total tonnage was continuing its postwar decline. A steel manufacturer, one who was witnessing successful

MARKETS

- What commodities do you produce?
- Are your customers retail, wholesale, or industrial users?
- Are they small or large?
- Are your markets geographically limited?

TRANSPORTATION SYSTEMS

- What modes do you use for distribution—transcontinental, regional, interplant movements, raw materials?
- In which of these markets is rail weakest?
- Do you ship to your own distribution centers or directly to customers?
- In plant location decisions, how relevant is rail access?
  - Have you considered piggyback?
  - Is the Sunbelt any different with respect to rail access?
- Are there commodity characteristics that affect your choice of mode?
  - What kinds of cars are used? Do you have special car requirements?
  - Is car or unit size suitable for you or for receiver?

RAIL CHARACTERISTICS

- Seasonality/peaking—any problems?
- Reliability—what proportion of movements are “on-time?”
  - Is travel time itself any problem?
  - To what do you attribute unreliability?
  - How do you perceive rail management attitudes? Compared to truckers?

RAIL RATES

- Have your rail rates been outstripping trucking rates?
- Are there particular products which are being priced out of the rail market?

INTERMODAL SERVICE

- Do you consider TOFC/COFC as an attractive alternative to conventional rail or truck?

FIGURE 1 SHIPPER INTERVIEW FORMAT

railroad attempts to win back some of his traffic, nevertheless remarked that the rail share of his traffic was 35%, versus a postwar figure of 90%.

For the commodities of interest in this examination, rail appears to be maintaining its grasp on some market segments and losing its grasp on others. Transcontinental and long-distance traffic continues to be carried by rail. The short- and medium-distance markets, however, are being eroded by truck competition, despite occasional rail reassertion. High-volume moves of most commodities continue to lean toward rail, with strong truck competition for the medium-volume moves. Low-volume moves are highly-oriented toward truck. Rail securely holds most of its traffic in low-value commodities but has a struggle maintaining its share of the traffic in medium- and higher-value commodities. In commodity markets that were not the subject of this investigation, of course, rail's performance might be entirely different.

Comments made by shippers about rail service are summarized by category below.

Rail Performance

Rail users were widely critical of railroad unreliability, particularly in the east. Most shippers attributed unreliability to terminal delays, although criticisms of travel time and equipment supply were common. All shippers, including those in the West, remarked that unreliability was generating a continuing diversion of traffic to truckers for many commodities.

Shippers provided many examples of the symptoms of unreliability. Travel times from California to the Midwest for one manufacturer averaged 8 days; a range of 5 to 12 days was common. Another complained of turnaround times of 1-1/2 months for medium-distance moves. Two producers described specific situations where rail service was so unreliable (in both cases compounded by equipment shortages) that business from certain locations amounting to millions of dollars annually was simply taken from the carriers involved and transferred, in one case to truckers, and in another to a competing railroad. More worrisome, however, has been a steady and marked increase in average turnaround times and, consequently, a de facto reduction in available car supply.

Severe weather in the East during 1977 and 1978 had an impact on reliability but shippers cited this as no more than a contributing cause. Some shippers perceive a resigned attitude on the part of rail management to right these problems. One producer, who formerly encountered and co-operated with aggressive railroad attempts to earn back some of his traffic, doubts he would accept those changes in today's environment.

The degree of unreliability in rail operations diminished from West to East, but no shippers escaped what they perceived to be a troubling uncertainty about adequate equipment supply and reliable travel times.

California producers, whose transcontinental movements were deemed fairly reliable, faced problems in local distribution in the East.

The causes of rail unreliability, as perceived by shippers, include lack of investment in locomotives and cars, poor road conditions, lingering effects of winter storms, the coal strike, and even the 1974 recession. All of these factors contribute to a railroad "syndrome" whose most damaging effect, at least in the eyes of shippers, is a complete lack of long-range planning by railroads. Although shippers acknowledge the cash flow problems of railroads, they perceive lack of investment as a cause, not an effect,

Most shippers attribute rail unreliability to terminal delays and switching requirements. Many terminal facilities are antiquated and inefficiently operated. Traffic is usually directed through a hierarchy of yards, sometimes at the rate of one move per shift or per day. A major shipper was highly critical of some terminal companies--with multiple ownership, many of them are undirected. Because some terminal companies receive flat switching fees and are not subject to per diem charges, they have no monetary incentives to handle cars quickly, and, as a consequence, their performance is poor.

One shipper believed that rail unreliability varied extensively by route and not simply by railroad or by region. He believed that some delays could be attributed to specific terminal areas, especially when interchange was required, and he undertook to avoid such trouble spots.

Travel times, on which producers place less importance, are nonetheless inadequate. In some markets, travel times are simply too long to compete with trucks. California was cited specifically in this regard, and short-distance moves in the East are considered equally handicapped. Shippers also cited inconsistency in travel times (i.e., poor on-time performance) as a serious inconvenience although this circumstance appears to derive from terminal delays and not line-haul performance.

Car supply problems compound rail unreliability significantly. These problems are explored in more detail later in this section.

Most shippers did not identify strong peaking patterns in their production or transportation. One automobile manufacturer, however, witnessed wide cyclical swings in his demand, with attendant car supply difficulties. Most shippers are capable of forecasting well in advance their car and rail service requirements in detail. Use of these forecasts, however, does not improve rail response.

Many shippers stressed the relationship between transportation and warehousing in their distribution plans, particularly for their customers. For high-value products, of course, the increased inventory requirements generated by rail unreliability are expensive. An automotive parts manufacturer abandoned rail almost entirely because of unreliability on the rail side and its impact on warehouse costs. Many shippers had very sophisticated means of monitoring these costs and could readily place a

price on rail unreliability. Some claimed that they could have closed some of their distribution centers with improved rail reliability, though most simply moved to truck.

Some producers, prepared to tolerate inadequate rail performance at their own plants, cannot tolerate such performance for their customers and still remain competitive, especially when their own competitors rely on truck.

In summary, there is considerable evidence from the interviews with shippers that rail unreliability is forcing shippers to turn to trucks. As rail reliability declines, some firms are abandoning rail as their own competitors move to highway transport and offer, in turn, better service that must be matched. Shippers consider yard operations and lack of planning and foresight the most critical factors contributing to rail unreliability. The most damaging impact of declining rail reliability is on shipper and customer warehousing operations; railroad attempts to arrest service deterioration would be most productive in this area.

Railroad Attitudes

Shippers consistently criticized the lack of aggressiveness and direction in railroad top managements in general. Some railroads, particularly those in the West and Midwest, were applauded for their efficiency, and, occasionally, their initiative. Eastern railroads were eyed more critically, although a chemical producer noted several examples of railroad attempts to recapture certain traffic. Some shippers see railroads lacking long-range planning--they respond to blunt cost-cutting pressures and not to revenue-producing concepts.

Although industries in which rail was market competitive were selected for the interview process, a limited number of shippers were convinced that railroads had no interest in transporting their products.

On the other hand, shippers were impressed with the resourcefulness of truckers. Many of the truckers used by shippers were small contract or irregular-route carriers, often owner-operated, whose low overheads and enthusiasm enabled them to offer dependable service at reasonable rates. Larger carriers were able to offer transportation packages over widespread areas that sometimes even surpassed those of the railroads.

Shippers considered truckers much more willing to undertake, or at least contribute to, comprehensive transportation service packages, and many companies perceived corporate cost savings if dependable distribution packages could be created and maintained.

At some high-volume plants, shippers were occasionally faced with trucker congestion. One traffic manager noted that almost 900 trucks had loaded at one large plant the previous day. Another traffic manager whose trucking activity was in the same league emphasized that equivalent volumes by rail would have reduced the number of movements by a factor of 4

or 5. At some plants, an adequate supply of appropriately equipped truckers was difficult to ensure. There was, therefore, clear evidence of relative rail advantages in situations where production activity was high.

A chemicals producer described a limited number of "exceptional" circumstances where one or more railroads aggressively sought his traffic. To combat barge transport of fairly high-volume traffic, railroads offered incentive and volume rates for jumbo equipment and, in one case, offered to supply cars for a chemical traditionally carried in shipper-owned cars. These efforts were accompanied by a shipper commitment to generate back-hauls. In another case, traffic that was shifted from barge to rail, at a higher transportation cost, enabled the producer to earn marketing advantages in an agricultural chemicals market. The same producer was, at the time of the interview, attempting to shift a high-volume truck move to rail in the Northeast.

A steel manufacturer, who was particularly sensitive to rail reliability and its inventory cost implications (as were his customers), described several rail-developed services that met or surpassed his performance requirements and brought about the shift of high volumes of traffic from truck to rail. In one case, a railroad modified cars with his product in mind and initiated an intermodal service from his plant to customers in a city 300 miles away, using a suburban yard as the transfer point. In another case, a "minitrain" service was developed for customers in another corridor of the same length. In both cases, service was so reliable that inventory requirements were vastly reduced for both producer and customer. The manufacturer, willing to extend this intermodal concept with modified cars into other markets, has seen rail labor reservations preclude this, but his enthusiasm for the services is very strong. For some of his products that are not moved on these special trains, however, the rail share of his traffic is eroding further.

These examples of rail's successful recapture of traffic through packages of rates, service, and equipment and an interaction with the producer underscore rail's ability to compete in the high-volume, low-value market, and in a few cases, in the high-volume, high-value market.

Whether comparably motivated attempts to recapture traffic from trucks in lower-volume commodities would be successful is not certain. Shippers did not provide examples of such successes.

Rail Rate Increases

Most shipper respondents were prepared to accept, in an inflationary environment, rising rail freight rates. Given that freight rate increases in recent years have been for the most part across-the-board, the burden of increased rates has been felt more acutely by producers of high-value commodities, in this case automobiles and automotive parts, steel, and some chemicals.

Many firms felt that rail rates were increasing faster than truck rates--one food manufacturer cited this as the prime contributor toward his shift to trucks. Some pointed to situations where rail and truck rates were comparable, but these were relatively infrequent. In fact, an automobile manufacturer indicated that, for most of his traffic, rail and truck rates were rarely at comparable levels. One respondent believed that truck tariffs were more sensitive to the ability of the product's market price to absorb the transportation cost.

Shippers generally believe that rail tariffs are being distorted by across-the-board rate increases and that truck tariffs are not quite so distorted. In situations where the two modes are fairly price-competitive, the rail approach to rate increases might be prejudicial to its market share. There is some evidence of this in the foods industry.

Two large scrap steel users argued that recent ICC-ordered rate hold-downs on recyclables were bringing about serious rail equipment shortages that were resulting in shipping scrap by truck. Use of trucks for a high-volume commodity like scrap steel is energy-inefficient and defeats, in part, the objectives of the hold-downs in the first place.

Rail Access

Most firms interviewed possessed rail access at their own high-volume plants, as did their larger customers. Small plants and receivers often had no access. In these smaller plants, shippers felt that volume was too low for reliable rail service and did not consider the lack of rail access to be a serious deficiency.

Some eastern producers of higher-value goods showed a definite trend to omit rail access in new plant and other facilities planning. Two producers were not building new plants with rail access. One of these firms was investing heavily in Sunbelt states and his plants were often 50 to 80 miles from the nearest railhead: only one fifth of his many plants had rail access. This trend, however, worried an automobile manufacturer, who saw his own costs increasing as a result.

In many cases, shippers did not consider rail an effective competitor to truck at small plants. Shippers saw TOFC/COFC as a potential competitor to highway transport, but few discerned a railroad interest in this traffic. Short-distance moves were usually assigned to trucks. One steel manufacturer, with one fifth of his output sold through service centers to small users, noted that this traffic moves almost in its entirety by truck.

Generally, rail was considered a strong competitor for high-volume moves, primarily because of its rate advantages. Transcontinental movements were almost exclusively by rail. In the East, high-volume medium-distance movements of chemicals were shipped by rail: barges were considered rail's strongest competitor. There was evidence in the East that trucks were eroding rail's high-volume, shorter-distance market: trucks were keenly fighting for this traffic, and rail response to the competition

ranged from passive to aggressive. In the Midwest, however, rail was succeeding in recapturing traffic in the same type of market.

Interplant movement of lower-value materials, where timeliness was not so critical, was often done by rail, although one producer was able to generate substantial truck competition for these middle- to high-volume moves.

With regard to plant location and rail access, then, there is a potential loss of rail tonnage to trucks as light manufacturing, in particular, moves to the Sunbelt states. New plants are being built without railroad service in mind, except via COFC or TOFC. This situation reflects, in part, the fact that many of these new facilities are small and difficult to serve adequately by rail and cannot offer backhauls, yet the situation portends an absolute decline in rail tonnage. There is no indication that the dissatisfaction with rail service borne by shippers in the north is being combatted by railroads in the south. Lastly, the traditional rail market of high-volume, medium-distance moves appears to be under attack by truckers, with partial results. Rail seems to be maintaining its grasp on the low-value commodity market and on long distance moves, however.

Car Design and Supply

Some of the shippers interviewed used boxcars for many of their movements. In addition, gondolas were used for scrap steel; tank cars for liquid (usually industrial) chemicals; refrigerators for fresh and frozen foods and wine; hoppers for solid (agricultural) chemicals; flatcars for steel; and autoracks for automobiles. One sugar producer considered the unequipped standard boxcar adequate, but most other producers preferred boxcars equipped with racks, movable bulkheads, or other equipment. Food producers required sophisticated packing to reduce damage. Where package sizes differed highly for one producer, he made extensive use of dividers, void fillers, and other dunnage materials, all at high expense. Most shippers preferred damage-free, cushioned-underframe cars.

Most shippers considered the standard carload lot a good unit of sale, a traditional one. Some considered a trailer or container unit size even better, particularly for regional distribution. One shipper believed he could reduce his distribution center stocks by shipping direct from factory to customer with smaller unit sizes.

Car supply was a major grievance among all shippers. Aggravated by poor weather, car shortages are commonplace. One shipper with a pool of more than 2,000 cars complained of slow turnaround times and poor maintenance, factors which contribute to particularly low utilization. Car supply, already inadequate to meet growing demand, is decreasing so strongly that even historical needs cannot be met. All producers claimed they were capable of forecasting their daily requirements well in advance, without a sensitive railroad response. These shippers indicated that car supply problems, which are exacerbated with increased design specialization, have directly resulted in the loss of certain movements. A chemical producer

who had his own fleet of tank cars (traditional in the industry) resented being forced to buy more cars to fend off car shortages. Allowances for his own equipment recovered less than half his costs. None of the shippers interviewed expressed any interest in owning his own equipment.

Food manufacturers, facing constant problems with car supply, pointed out that despite projections for high growth in fresh and frozen foods, railroads were simply not building refrigerator cars. The supply of gondolas for scrap steel, as well, has become highly strained.

In conclusion, most shippers consider the standard railcar adequate, if imperfect. Ideally, many would prefer cars that are specifically equipped for their traffic; in the absence of this ideal, they would be pleased with cars that are at least rudimentally equipped for their products. Most shippers are seriously handicapped by equipment shortages that show little sign of being righted.

Intermodal Service

Most shippers consider intermodal service an attractive alternative to exclusive rail or truck use, particularly for traffic that is presently undergoing the strongest rail service deterioration. Many perceive a railroad disinterest in intermodal service that varies indirectly with the rail proportion of the tariff.

Most shippers prefer intermodal service because of reduced damage, better lot sizes, and other factors, but the primary benefits of intermodal service are increased reliability. Reliability improvements are considered a direct function of reduced switching requirements. Intermodal service at the present time, however, is compromised by car supply problems and lack of adequately equipped yards.

Some shippers believe that more extensive use of intermodal service might enable them to reduce their inventory requirements and, in the longer term, their warehouse fixed facilities.

Shippers are not convinced, however, that intermodal service is the solution to their distribution problems, and some are restrained in their endorsement of COFC/TOFC. This restraint is fostered in part by past experience with the railroads in carload service and by the railroads' lack of enthusiasm for intermodal service. Although TOFC might be a promising option for these shippers in some market segments, both shippers and carriers appear resistant: a "show me" attitude predominates.

There was no consensus among shipper respondents that increased tariffs for intermodal service are acceptable. Given strong moves to truck transportation in these market segments, at rates that are at least equal to TOFC rates, there is indirect evidence that producers would be willing to pay these rates if service was dependable.

Intermodal service has offered, for some products, a means of accommodating the moves by customers and suppliers to the Sunbelt states. The attractiveness of TOFC service for a small plant that might be as much as 100 miles from the nearest major railhead has been identified, yet railroad response has been lukewarm.

Intermodal service concepts have been used to recapture some traffic in steel products in the Midwest. Aggressively marketed by the participating railroad, the service has enjoyed strong shipper acceptance.

Marketing

Many shippers considered the marketing of railroad services deficient. A foodc manufacturer with complex distribution activities was particularly critical of railroad marketing. Shippers demanded both an adequate supply of appropriate equipment and reliable delivery times and were willing to pay for these services. One shipper, however, complained that equipment, service, and rate factors were usually presented to him independently and not as a package of characteristics he could evaluate and plan for. Many shippers voiced the opinion that railroad marketing concepts were meager compared to those prevalent in manufacturing industries and perceived, as a logical corollary to effective marketing, that premium services at premium prices should be more extensively offered by railroads. Some shippers noted that changes in service had often been made by railroads with little acknowledgment that the previous service characteristics were, in the eyes of the shipper, directly tied to rate and equipment supply agreements that were hence violated. The positive attributes of TOFC service are the identifiability of its performance characteristics and the clarity with which shippers can evaluate their production and transportation options. Such improvements are not impossible to achieve in conventional rail operations. Indeed, shippers argue that for some traffic sectors slightly unconventional railroad approaches might earn significant benefits for the carriers.

V RAILROAD IMPROVEMENT ALTERNATIVES

Shippers consistently cited unreliability as a barrier to their increased use of the rail mode. Complaints of equipment shortages could frequently be linked to long transit times that extended the car cycles and reduced the effective fleet size. The avoidance of delays incurred in terminals was cited as the most promising avenue for change. Even preferences for TOFC or COFC were justified on the basis of avoiding terminal delays.

Given the need to improve delivery time reliability year in and year out, what can railroad operating companies reasonably be expected to do? The SRI project team considered a number of alternatives for improving rail service and considered the difficulties likely to be encountered in implementing these alternatives. Barriers to implementing changes, in order of increasing difficulty to overcome, were identified as:

- Changes to operating practices
- Capital outlays
- Increased operating costs
- Changes to work rules
- Changes in regulations.

Opportunities for service improvement, ranked by increasing difficulty of implementation, are:

- Rationalization of crew assignments in terminal yards
- Rationalization of train departure schedules
- Rationalization of system blocking to bypass intermediate yards
- Rationalization of complex terminal areas
- Door-to-door scheduling of freight movements
- More frequent train departures.

A discussion of these opportunities is presented below.

Rationalization of Crew Assignments in Terminal Yards

Transit times suffer in terminal areas because cars are frequently moved through several yards before they are placed in a road train or delivered to a customer. At each yard within the terminal, a car may have to wait because crews are not available to work on the car, resulting in

delays of one or more 8-hr shifts. Studies performed for the Federal Railroad Administration (FRA) for Title 9 of the 4R's Act indicate that car flow in major terminals can be improved by adjusting crew assignments in the yards. Adjusting crew assignments to provide for more expeditious movement of cars can usually be done within existing work rules. To achieve the benefits of this rationalization, studies of car flows through the terminal are required. Alternative crew assignments should be explored to determine the best plan for moving cars through the terminal.

Rationalization of Train Departure Schedules

If a departing train leaves soon after the scheduled arrival of inbound trains with connecting traffic, the inbound traffic must frequently wait 24 hr for the next outbound departure. Studies performed for the FRA at MIT indicate that scheduling of outbound trains to pick up more inbound cars and to allow for more variation in arrival of inbound trains can improve travel time and reliability. Significant improvements were found in some situations by delaying train departures. Additional improvements were forecast from better adherence to schedules. Such adjustments can also be done within existing work rules, and at no additional cost if the same number of trains is operating.

While the schedules are important, getting the cars on the earliest outbound train is also important. Careful monitoring of the time used to move cars through the yard will help ensure that they meet the earliest outbound schedule. The computation and reporting of car detention times in yards can be performed by existing management information systems.

Rationalization of System Blocking to Bypass Intermediate Yards

Because classification yards act as storage buffers to accumulate cars until full trains can be operated, and because of uncertainty in meeting outbound train schedules, cars frequently wait in classification yards for about 24 hr before proceeding to the next phase of their journey. Eliminating an intermediate classification can thus save about one day in travel time and at the same time improve car availability by shortening the car cycle time. Planning methods developed for The United States Railway Association's design of the CONRAIL blocking and scheduling described in the "Final System Plan" can enable analysts to evaluate alternative plans. Approximately 10 railroads have used the technique to evaluate system improvements. Blocking plan changes require no changes in work rules but may require capital improvements to yards where more or bigger blocks must be made.

Rationalization of Complex Terminal Areas

To solve some of the problems with terminal areas, elimination of some terminal yards and consolidation of work in others may provide more reliable transit time and lower cost. This rationalization is more difficult

than rationalization of crews because work rules and job protection may apply to workers in yards that are abandoned, and capital improvements may be needed to improve the consolidated facilities. In some urban areas, land freed by such rationalization may be valuable and the sale price may justify the rationalization. In other locations, such as East St. Louis, Illinois, an excess of land from such a source has kept property values low.

Experiments with modification of work rules in major terminal areas have been undertaken in the Joint Terminal Study in the St. Louis area, where organized workers are protected against economic loss by the FRA while different rules are evaluated. Some rule changes have resulted in significant improvements in transit time and have affected worker income to a very minor degree.

Door-to-Door Scheduling of Freight Movements

As part of the car utilization improvement program, the FRA, the Association of American Railroads, and the Missouri Pacific Railroad have developed a computerized system of planning freight car movements from shipper to receiver and of programming the empty return trip. With such planning, opportunities for improvement are more readily seen. More importantly, however, deviations from schedules are more obvious, and remedial action is more readily taken. If the experience is successful, the use of this system is expected to improve transit time and will enable more positive status reporting of shipments.

The use of such a system is expected to be costly in terms of computing hardware and software. Extensive changes in operating philosophy and procedures will be required to take full advantage of the system. These changes will require time to develop.

More Frequent Train Departures

Operation of trains on more frequent schedules will cut down the effects of missed connections and provide fewer breakdowns because of shorter trains. Yard time for making up these shorter trains would be more than proportionally reduced because long trains may require additional handling. Because the train is shorter, it can be more specialized, providing direct service to additional points.

The out-of-pocket cost of operating shorter, more frequent trains is higher, but the advantages listed above, plus increased revenue from more reliable service, may offset these higher costs. In addition, reduced crew consists for shorter trains are being negotiated, with the possible result that lower costs and more widespread use of shorter, more frequently scheduled trains will result.

Thus the railroad operating companies have opportunities to make improvements in reliability over cost ranges that can be justified by

additional traffic that is captured. Combinations of techniques may be used to provide additive benefits for several steps in a shipper-to-consignee movement.

Whatever is done to improve reliability, the steps taken should be identified as clearly as possible. The reliability improvement should be carefully included in the marketing of the improved service, with necessary equipment and rate components.

VI HYPOTHETICAL CASE STUDIES

The summary of shipper interviews described various circumstances where truck competition was eroding traditional rail markets. There were, however, other circumstances where rail had successfully overcome truck competition. This chapter presents six hypothetical case studies and describes the cost, service, and energy implications of both rail and truck modes. Data on volume, commodity, and origin and destination have been developed subjectively; nevertheless they represent circumstances described by shippers and have been tailored as closely as possible to the real world.

Identification of Case Studies

Interviews with shippers revealed that the extent of truck penetration into rail markets varied with the type of market, at least as described by commodity value, distance, and volume. No widespread erosion in trail traffic was evident in transcontinental movements, for example, nor in very high-volume moves or in low-value commodities.

The case studies presented below were developed selectively to address rail service problems in markets described above.

West Coast shippers revealed that they used rail infrequently to their markets west of the Rockies because truck offered substantially improved reliability and travel times. These comments led directly to the development of Case Study 1:

- Case Study 1: This case involves the shipment of a medium-value commodity, aluminum products, over a long haul from a refinery in Washington State to various users in the San Francisco Bay Area. The annual volume involved is low.

Shippers also revealed that rail unreliability presented serious problems over long distances in the East as well, even when volumes were higher. Case Study 2 addresses this problem:

- Case Study 2: This case involves the shipment of a medium-value commodity, canned foods, over a long haul from a Chicago manufacturer to his New York area distribution center. The annual volume involved is medium.

Case Studies 1 and 2 focus on deteriorating rail markets involving long distances and medium-value commodities. Case Study 3 attempts to describe a somewhat similar situation but one that calls for unconventional rail service alternatives:

- Case Study 3: This case is oriented toward a high-value commodity, automotive parts, manufactured at several small plants in North Carolina, consolidated at Winston-Salem, and then dispatched over a fairly long haul to Detroit. Aggregate volume is medium, although the supply from individual plants is quite low.

Case Study 3 directly addresses the rail service losses incurred as manufacturers shift more and more of their production facilities to Sunbelt locations where direct rail access is not provided.

Many shippers revealed that there was increasing truck competition in short-haul markets where traffic volumes were medium to high. These markets are those addressed by Case Studies 4 through 6.

One promising rail response to truck competition is the development of an intermodal service for steel products. This situation is the focus of Case Study 4:

- Case Study 4: This case involves the shipment of a high-value commodity, steel products, over a short distance from Chicago to St. Louis. Annual volume is medium.

There were, furthermore, some instances of aggressive truck behavior in high-volume, short-distance moves of chemicals in the Northeast, as described in Case Study 5:

- Case Study 5: This case involves the movement of industrial chemicals (sulphuric acid) in very high volumes between a Baltimore producer and a Pittsburgh steel manufacturer.

Lastly, many rail shippers suffered so extensively in local distribution of their products in the Northeast that they were shifting to truck. Case Study 6 hypothesizes one such example:

- Case Study 6: This case involves the transfer of mixed packaged foods, consolidated at a distribution center near Boston, to super-market warehouses between Boston and New York. Annual volume is assumed to be fairly high.

Transportation Alternatives

Based on the subjects of interest presented above, alternative transportation service characteristics of the cases were developed. The objective in all cases was to compare rail and truck services. Various rail strategies were developed to accommodate transportation needs. Table 9 highlights the traffic characteristics of each of the cases and the types of transportation responses considered for them. Specific details of the service characteristics are introduced later.

Table 9

GENERAL CHARACTERISTICS OF CASE STUDIES

<u>Case Study</u>	<u>Annual Volume (Tons)</u>	<u>Distance (Mi)</u>	<u>Commodity Value</u>	<u>Type of Operation</u>	
				<u>Rail</u>	<u>Truck</u>
1. Aluminum	12,500 (low)	900 (long)	Medium	Conventional	Conventional
2. Canned foods	50,000 (medium)	908 (long)	Medium	Conventional	Conventional
3. Automotive parts	50,000 (medium)	849 (long)	High	TOFC	Conventional
4. Steel products	75,000 (medium)	282 (short)	Medium	Modified TOFC	Conventional
5. Sulphuric acid	250,000 (high)	328 (short)	Low	Unit trains	Conventional
6. Packaged foods	100,000 (medium)	248 (short)	Medium	Conventional	Conventional

Cost and Energy Estimates

The objective of the development of case study examples was to compare the cost and energy consumption characteristics of rail and truck alternatives. Given the traffic characteristics and operations strategies introduced above and bolstered from other sources such as the Carload Waybill Statistics, detailed case study characteristics were defined. Subsequently, the case studies were modeled, and cost and energy implications were developed. Tables 10 through 15 exhibit all relevant inputs and outputs of that exercise.

The data in the tables are derived from a variety of model sources. The line-haul rail costs and energy consumption figures were developed from SRI's Long-Run Average Cost and Energy Model (LRAC), which simulates rail operations in considerable detail and has been the principal means of investigating railroad operations in this and earlier exercises in transportation energy conservation.

The switching and overhead rail costs presented in the exhibits are reasonable estimates, but have not been examined in detail.

Trucking costs were developed from a framework described in Reebie Associates, "National Intermodal Network Feasibility Study," prepared for the U.S. Department of Transportation in 1976. This framework was modified for the purposes of this project, and unit costs were inflated to 1978.

For the case studies involving intermodal activity in the rail strategy, the costs of terminal handling were developed in considerable detail from a model described in the 1976 Reebie Associates study. Only the final per-unit approximation is presented in the tables. Truck pickup and delivery costs for the intermodal case studies were produced in detail according to a methodology similar to the line-haul trucking model, although many assumptions were altered to better reflect urban trucking characteristics.

Selected major line-haul cost components are highlighted in Tables 10 through 15. No attempt was made to specifically identify other cost and performance characteristics produced by the models.

Generally, rail costs were developed for various cars per train and line-haul speed combinations; the lowest-cost combination is presented. Characteristics of rail operations presented in Tables 10 through 15 could be improved by more frequent departures or increased speeds, although higher cost and energy consumption implications would result. Truck services have considerably less operational flexibility available to them.

Table 10

Case Study 1

ALUMINUM PRODUCTS SHIPPED IN LOW
VOLUMES OVER LONG DISTANCES

TRAFFIC DESCRIPTION		OPERATIONS CHARACTERISTICS		RAIL COSTS			TRUCK COSTS			
			Rail	Truck	Cost Components	Unit Cost	Weekly Costs	Cost Components	Unit Cost	Weekly Costs
Commodity	Refined Aluminum Shapes SIC 3352 (sheet, rods, etc.)	Operations Description	Dispatches twice a week; Conventional operations	Dispatches 1.6 times per day	Line-haul Costs	1.147¢ per ton-mile	\$2,478	Line-haul Costs [§]	\$0.711 per mile	\$6,605
Origin	Seattle, Washington; smelter	Equipment Type	Conventional box-cars; unequipped	One 45-foot trailer	[Road] [°] [Equipment] [†] [Fuel] [Labor]	[0.617¢] [0.200¢] [0.056¢] [0.213¢]	[1,333] [432] [121] [460]	[Road Taxes] [§] [Equipment] [§] [Fuel] [Labor]	[\$0.027] [\$0.144] [\$0.065] [\$0.420]	[251] [1,277] [563] [3,624]
Destination	San Francisco Bay Area; various small receivers	Load Characteristics	56.7 tons per car; 4.2 cars per week	25 tons per trailer; 9.6 trips per week	Switching	\$35 per switch	\$350	Terminal Handling	--	--
Volume	12,500 tons per year--240 tons per week	Terminal Operations	5 yard switches--2 industrial; 2 classification; 1 interchange	No intermediate handling	Overhead	0.250¢ per ton-mile	\$540	TOTAL	--	\$6,605
					TOTAL	--	\$3,368	Average	Per ton-mile	3.06¢
Distance	900 miles	Line-haul Speed	30 mph	50 mph	Average	Per ton-mile	1.56¢			
		Fuel Consumed	336 gallons per week ;0.00155 per ton-mile	1,490 gallons per week; 0.00690 per ton-mile						

° Assumes 20 million net tons per year

† Assumes 25% car utilization

§ Presentation excludes certain constant costs.

Table 11

Case Study 2

CANNED FOODS SHIPPED IN MEDIUM
VOLUMES OVER LONG DISTANCES

TRAFFIC DESCRIPTION		OPERATIONS CHARACTERISTICS		RAIL COSTS			TRUCK COSTS			
			Rail	Truck	Cost Components	Unit Cost	Weekly Costs	Cost Components	Unit Cost	Weekly Costs
<u>Commodity</u>	Canned foods SIC 2033	<u>Operations Description</u>	Dispatches daily; conventional operations	Dispatches 6.4 times per day	Line-haul Costs	1.064¢ per ton-mile	\$ 9,275	Line-haul costs [§]	\$0.711 per mile	\$26,639
<u>Origin</u>	Chicago, Illinois; food manufacturer	<u>Equipment Type</u>	Boxcars; damage-free/ cushioned underframe	One 45-foot trailer	[Road] [°] [Equipment] [†] [Fuel] [Labor]	[0.423¢] [0.283¢] [0.062¢] [0.225¢]	[3,661] [2,510] [540] [1,961]	[Road taxes] [§] [Equipment] [§] [Fuel] [Labor]	[\$0.027] [\$0.144] [\$0.065] [\$0.420]	[1,011] [5,151] [2,273] [14,627]
<u>Destination</u>	Suburban New York; distribution center	<u>Load Characteristics</u>	33.5 tons per car; 18.0 cars per week	25 tons per trailer; 38.4 trips per week	<u>Switching</u>	\$35 per switch	\$ 840	Terminal Handling	--	--
<u>Volume</u>	50,000 tons per year-- 960 tons per week	<u>Terminal Operations</u>	4 yard switches --2 industrial; 2 classification	No intermediate handling	<u>Overhead</u>	0.250¢ per ton-mile	\$ 2,179	TOTAL	--	\$26,639
<u>Distance</u>	908 miles							Average	Per ton-mile	3.06¢
		<u>Line-haul Speed</u>	30 mph	50 mph	TOTAL		\$12,294			
					Average	Per ton-mile	1.41¢			
		<u>Fuel Consumed</u>	1,476 gallons per week; 0.00159 per ton-mile	6,012 gallons per week; 0.00690 per ton-mile						

[°] Assumes 30 million net tons per year

[†] Assumes 25% car utilization

[§] Presentation excludes certain constant costs.

Table 12

Case Study 3

AUTO PARTS SHIPPED IN LOW
VOLUMES OVER LONG DISTANCES

TRAFFIC DESCRIPTION			OPERATIONS CHARACTERISTICS		RAIL COSTS			TRUCK COSTS		
			Intermodal Rail	Truck	Cost Components	Unit Cost	Weekly Costs	Cost Components	Unit Cost	Weekly Costs
<u>Commodity</u>	Motor vehicle parts SIC 3714	<u>Operations Description</u>	Rail dispatches every two days; pickup by truck, transferred at intermodal yard	Dispatches 7 times per day from consolidation point; once per day from origins	Line-haul Costs	1.196¢ per ton-mile	\$8,445	Line-haul Costs [§]	\$0.711 per mile	\$22,743
<u>Origin</u>	Various small manufacturers within 200 miles of a Winston-Salem North Carolina consolidation point	<u>Equipment Type</u>	TOFC flatcars	One 45-foot trailer	[Road] [°] [Equipment] [Fuel] [Labor]	[0.511¢] [0.184¢] [0.070¢] [0.323¢]	[3,608] [1,299] [494] [2,881]	[Road Taxes] [§] [Equipment] [§] [Fuel] [Labor]	[\$0.027] [\$0.144] [\$0.065] [\$0.420]	[864] [4,356] [1,909] [12,286]
<u>Destination</u>	Detroit; auto manufacturers	<u>Load Characteristics</u>	50 tons per car; 19.2 cars per week	24.1 tons per trailer; 39.9 trips per week	Truck Pickup and Delivery	\$0.711 per mile	\$1,941	Pickup and Delivery [§]	\$0.711 per mile	\$1,941
<u>Volume</u>	50,000 tons per year--962 tons per week	<u>Terminal Operations</u>	No intermediate handling; intermodal transfer at one end	No intermediate handling except at consolidation center	Intermodal Yard Handling	\$17.25 per truckload	\$688	Terminal Handling	--	--
<u>Distance</u>	734 miles from consolidation point to Detroit; average of 115 from origins to consolidation point	<u>Line-haul Speed</u>	30 mph	50 mph	Overhead	0.250¢ per ton-mile	\$1,765	TOTAL	--	\$24,684
		<u>Fuel Consumed</u>	2,107 gallons per week; 0.00258 per ton-mile	5,841 gallons per week; 0.00715 per ton-mile	TOTAL	--	\$12,839	Average	Per ton-mile	3.02¢
					Average	per ton-mile	1.57¢			

[°]Assumes 30 million net tons per year[†]Assumes 50% car utilization[§]Presenation excludes certain constant costs.

Table 13

Case Study 4

STEEL PRODUCTS SHIPPED IN
MEDIUM VOLUMES OVER SHORT DISTANCES

TRAFFIC DESCRIPTION			OPERATIONS CHARACTERISTICS		RAIL COSTS			TRUCK COSTS		
			Rail	Truck	Cost Components	Unit Cost	Weekly Costs	Cost Components	Unit Cost	Weekly Costs
<u>Commodity</u>	Steel sheet and strip SIC 33123	<u>Operations Description</u>	Rail dispatches daily; pickup by truck, transferred to intermodal train at suburban yard 17 miles from origin	Dispatches 7 times daily	Line-haul Costs	1.644¢ per ton-mile	\$6,282	Line-haul Costs [§]	\$0.711 per mile	\$11,934
<u>Origin</u>	Chicago, Illinois; steel manufacturer				[road] [°]	[1.232¢]	[4,708]	[Road Taxes] [§]	[\$0.027]	[458]
					[equipment] [†]	[0.112¢]	[428]	[Equipment] [§]	[\$0.144]	[2,127]
					[fuel]	[0.053¢]	[203]	[Fuel]	[\$0.065]	[883]
					[labor]*	[0.156¢]	[596]	[Labor]	[\$0.420]	[5,678]
<u>Destination</u>	St. Louis, Missouri, various industrial steel users	<u>Equipment Type</u>	modified general-service flatcars	one 45-foot trailer	Truck Pickup and Delivery ⁺	\$43 per truckload in Chicago; \$19 in St. Louis	\$2,993	Terminal Handling	--	--
<u>Volume</u>	75,000 tons per year -- 1,442 tons per week	<u>Load Characteristics</u>	74.0 tons per car; 19.4 cars per week	30 tons per trailer; 48 trips per week				TOTAL	--	\$11,934
		<u>Terminal Operations</u>	No intermediate switching; intermodal transfer at both ends	No intermediate switching	Intermodal Yard Handling	\$17 per truckload	\$1,656	Average	per ton-mile	2.93¢
<u>Distance</u>	282 miles				Overhead	0.250¢ per ton-mile	\$ 955			
		<u>Line-Haul Speed</u>	30 mph	50 mph	TOTAL	--	\$11,886			
		<u>Fuel Consumed</u>	1,205 gallons per week; 0.0029¢ per ton-mile	2,334 gallons per week; 0.00574 per ton-mile	Average	per ton-mile	2.92¢			

[°]Assumes 10 million net tons per year.

[†]Assumes 50% car utilization.

*Assumes 50% crew sizes

⁺Assumes empty return

[§]Presentation excludes certain constant costs.

Table 14

Case Study 5

INDUSTRIAL CHEMICALS SHIPPED IN
VERY HIGH VOLUMES OVER SHORT DISTANCES

TRAFFIC DESCRIPTION		OPERATIONS CHARACTERISTICS			RAIL COSTS			TRUCK COSTS		
			Rail	Truck	Cost Components	Unit Cost	Weekly Costs	Cost Components	Unit Cost	Weekly Costs
<u>Commodity</u>	Sulphuric Acid SIC 28193	<u>Operations Description</u>	Dispatches three times a week; unit train operations	Dispatches hourly	<u>Line-haul Costs</u>	1.587¢ per ton-mile	\$25,038	<u>Line-haul Costs[§]</u>	\$0.617 per mile	\$68,996
<u>Origin</u>	Baltimore, Maryland; chemical producer	<u>Equipment Type</u>	Jumbo hopper cars	One large tank truck	[Road] [°]	[0.764¢]	[12,053]	[Road taxes] [§]	[\$0.014]	[1,635]
					[Equipment] [†]	[0.154¢]	[2,430]	[Equipment] [§]	[\$0.114]	[12,320]
					[Fuel]	[0.072¢]	[1,136]	[Fuel]	[\$0.062]	[6,518]
					[Labor]	[0.463¢]	[7,305]	[Labor]	[\$0.400]	[41,932]
<u>Destination</u>	Pittsburgh, Pennsylvania; steel plant	<u>Load Characteristics</u>	87.2 tons per car; 20 cars per train	30 tons per truck; 160 trips per week	<u>Switching</u>	--	--	<u>Terminal Handling</u>	--	--
		<u>Terminal Operations</u>	No intermediate handling	No intermediate handling	<u>Overhead</u>	0.0250¢ per ton-mile	\$ 3,944	TOTAL	--	\$68,996
<u>Volume</u>	250,000 tons per year -- 4,810 tons per week	<u>Line-Haul Speed</u>	30 mph	50 mph	TOTAL	--	\$28,982	Average	per ton-mile	4.37¢
					Average	per ton-mile	1.84¢			
<u>Distance</u>	328 miles	<u>Fuel Consumed</u>	2,996 gallons per week; 0.00190 per ton-mile (including empty return)	18,097 gallons per week; 0.01147 per ton-mile						

[°]Assumes 20 million net tons per year[†]Assumes 75% car utilization[†]Unit costs for this case assume higher-than-average utilization of equipment[§]Presentation excludes certain constant costs

Table 15
Case Study 6

PACKAGED FOODS SHIPPED IN
HIGH VOLUMES OVER SHORT DISTANCES

TRAFFIC DESCRIPTION		OPERATIONS CHARACTERISTICS ⁺		RAIL COSTS ⁺			TRUCK COSTS ⁺			
			Rail	Truck	Cost Components	Unit Cost	Weekly Costs	Cost Components	Unit Cost	Weekly Costs
<u>Commodity</u>	Prepared foods SIC 203	<u>Operations Description</u>	Dispatches daily; conventional short-haul operations	Dispatches 16 times per day	Line-Haul Costs	1.659¢ per ton-mile	\$8,103	Line-haul Cost ⁵	\$0.711 per mile	\$21,593
<u>Origin</u>	Suburban Boston; Distribution center	<u>Equipment Type</u>	Boxcars; damage-free/ cushioned underframe	one 45-foot trailer	[Road] ^o [Equipment] [†] [Fuel] [Labor]	[0.511¢] [0.590¢] [0.673¢] [0.419¢]	[2,437] [2,814] [348] [1,998]	[Road Taxes] ⁵ [Equipment] ⁵ [Fuel] [Labor]	[\$0.027] [\$0.144] [\$0.065] [\$0.420]	[830] [3,793] [1,556] [10,008]
<u>Destination</u>	Various food retail- er warehouses be- tween Boston and New York	<u>Load Character- istics</u>	43.2 tons per car; 39.9 cars per week	20 tons per trailer 96.2 trips per week	Switching	\$35 per Switch	\$315	Terminal Handling	-	-
<u>Volume</u>	100,000 tons per year -- 1,923 tons per week	<u>Terminal Operations</u>	3 yard switches - 2 industrial; 1 classi- fication	No intermediate handling	Overhead	0.250¢ per ton-mile	\$1,992	Total	-	\$21,593
<u>Distance</u>	248 miles to New York; via Spring- field	<u>Line-Haul Speed</u>	30 mph	50 mph	Total	-	\$9,610	Average	Per ton- mile	4.53¢
		<u>Fuel Consumed⁺</u>	1,028 gallons per week; 0.00215 per ton-mile	4,113 gallons per week; 0.00863 per ton-mile	Average	Per ton- mile	2.02¢			

⁺ Assumes all loads shipped full 248 miles

^o Assumes 30 million net tons per year

[†] Assumes 11.3% car utilization

⁵ Presentation excludes certain constant costs

Railroad Cost Sensitivity

Railroad costs are highly sensitive to capital factors. The unit costs presented in Tables 10 through 15 greatly depend on the assumptions regarding road and equipment utilization.

Rail investment in road and track varies little with the amount of traffic carried. Conversely, the cost of road investment and maintenance per ton-mile falls dramatically with increasing traffic. For example, at 5 million tons of traffic a year, total line-haul costs for a hypothetical rail line might approach 3.5¢ per ton-mile, of which the road-related component would represent 2.0¢. However, at 30 million tons, road-related costs would fall to 0.35¢ per ton-mile, pulling total costs down to 1.3¢. The road costs presented in the tables assume certain identified levels of annual traffic that are reasonable estimates, usually from 10 to 30 million tons a year, for the corridors described. It should be emphasized, however, that as much as a quarter of a cent per ton-mile is attributable to this annual traffic assumption as compared to a traffic assumption that is 10 million tons greater or less.

Furthermore, average unit costs of rail rolling stock depend highly on the level of utilization of this equipment. The average railcar is used, in fact, only 2.72 hr per day. It spends the rest of its time idle or empty. The equipment ownership estimates presented in Tables 10 through 15 assume a stated level of car utilization. Again, as much as a quarter of a cent per ton-mile can be attributable to a 25% change in availability.

VII EVALUATION OF CASE STUDIES

The case studies introduced and described in the previous chapter relate to situations described by shippers where rail's share of the transportation market has been under strong pressure from truckers. In this section the cost, energy, and service comparisons of appropriate rail operations strategies and their truck operations counterparts are evaluated.

The data presented in Tables 10 through 15 indicate that, in most cases, rail costs are about half those of truck competitors but frequency and travel time considerations strongly favor trucks. In fact, many shippers acknowledged rail's rate advantages but felt that these were offset by service deficiencies. Table 16 provides a comparison of rail and truck services according to the factors that most strongly influence shipper modal choice.

Table 16 underscores significantly higher fuel economy in rail operations. This circumstance is well known. Generally, rail productivity is from two to four times greater, although this advantage would be weakened as switching increased.

Although the case study alternatives do not take into account all of the decisions of shippers, it is possible to estimate the national effects of shifts from truck to rail in the commodities and markets that have been addressed. Table 17 indicates potential national savings in cost and energy consumption with shifts to rail. For each commodity, the table notes the present ton-mileage (based on the 1972 Census of Transportation); the proportion of that traffic that is accounted for by surface carriers (rail, common and private trucks); and the rail proportion of the surface traffic. The table also identifies the proportion of ton-miles accounted for by distance windows for which the case studies are representative. For example, the conclusions of the canned foods case study are considered relevant only for movements of from 500 mi to 1,500 mi, which comprise 36.0% of total canned foods ton-mileage. Similarly, only traffic in large shipments (those over 15 tons) is believed attractive to the rail service strategies so presented: this segment comprises 89.6% of canned foods ton-mileage.

The "sensitive" ton-mileage row in Table 17 is the product of national ton-miles and:

- Surface carrier modal split.
- Proportion of ton-miles accounted for by the representative distance window.
- Proportion of ton-miles accounted for by large shipments.

Table 16

SELECTED TRANSPORTATION CHARACTERISTICS OF CASE STUDY OPERATIONS

Case Study	Rail Service Characteristics				Truck Service Characteristics			
	Travel Time (hr)	Trips per Week	Cost* (¢)	Fuel Consumption† (gal)	Travel Time (hr)	Trips per Week	Cost* (¢)	Fuel Consumption† (gal)
1. Aluminum	30	2	1.56	1.6	18	10	3.06	6.9
2. Canned foods	30	6	1.41	1.7	18	38	3.06	6.9
3. Auto parts	27	4	1.57	2.6	17	40	3.02	7.2
4. Steel products	9	7	2.92	3.0	6	48	2.93	5.7
5. Sulphuric acid	11	3	1.84	1.9	7	160	4.37	11.5
6. Packaged foods	8	7	2.02	2.2	5	96	4.53	8.6

*Per ton-mile.

†Per 1,000 ton-miles, including switching operations.

Table 17

ESTIMATES OF NATIONAL COST AND ENERGY SAVINGS RESULTING
FROM SHIFTS TO RAIL FOR SELECTED COMMODITIES

		<u>Aluminum</u>	<u>Canned Foods</u>	<u>Automotive Parts</u>	<u>Steel</u>	<u>Sulphuric Acid</u>
National ton-miles (millions)		2,116	3,700	7,000	10,420	828
Surface carrier modal split		98.5%	98.5%	98.6%	93.0%	83.5%
Rail modal split		38.0%	54.3%	73.0%	41.9%	59.0%
Proportion of ton-miles accounted for by distance window identified	Window (mi)	500-1,500	500-1,500	500-1,500	200-500	0-500
		41.1%	36.0%	31.0%	48.8%	93.3%
Proportion of ton-miles accounted for by large shipments		78.5%	89.6%	72.7%	90.7%	98.6%
"Sensitive" ton-miles (millions)		672	2,764	1,555	4,289	672
Savings earned per 1% change	Cost (\$)	101,000	456,000	225,000	4,000	161,000
in "sensitive" modal split	Energy (gal)	36,000	144,000	71,000	119,000	61,000

Sources: Census of Transportation, "Commodity Transportation Survey" (1972); SRI International.

Note: Local distribution of packaged foods (represented by Case Study 6) is not described in this table.

Again, for canned foods, only 2,764 million ton-miles of the 8,700 million national total is assumed to be sensitive to rail/truck competition for this commodity. The methodology used to generate the "sensitive" total assumes general relationships; the Census of Transportation does not interrelate all these factors.

The last rows attempt to estimate the cost and energy savings inherent in each shift of 1% of the traffic in the "sensitive" category from truck to rail. For canned foods, these savings amount to \$456,000 and 145,000 gal of diesel fuel for each 1% change in modal split. A 1% change is equivalent to 28 million ton-miles of canned foods traffic.

The examples presented in Table 17 are by no means representative of potential savings in other commodity groups or of savings generated by different rail alternatives to the same problems addressed in this report. Furthermore, they do not put a price on rail travel time and reliability disadvantages. These service characteristics are considered by some shippers to be the primary determinant of mode choice.

Given these qualifications, an estimate of the cost and energy savings brought about by a total shift of all present truck traffic in the "sensitive" categories to rail can be developed. The ranking provided in Table 18 provides interesting comparisons but assumes developments that are highly unlikely.

Table 18

ESTIMATES OF COST AND ENERGY SAVINGS RESULTING
FROM TOTAL SHIFT OF SENSITIVE TRAFFIC FROM TRUCK TO RAIL

<u>Commodity</u>	<u>Maximum National Savings</u>	
	<u>Cost Savings</u> (millions of dollars)	<u>Energy Savings</u> (millions of gallons)
Canned foods	16	5
Sulphuric acid	7	2
Steel sheet	0	7
Aluminum shapes	6	2
Motor vehicle parts	6	2