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CONTAINER TECHNOLOGY STUDY
Volume II: Appendixes

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FINAL REPORT

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16. Abstract

Volume II has nine appendixes as follows:

Appendix A - Railroad Flatcar Data

Appendix B - Calculations

Appendix C - Record of Telephone Calls

Appendix D - Industry Interviews

Appendix E - Field Trips and Conferences

Appendix F - Annotated Bibliography

Appendix G - Patents Reviewed

Appendix H - Literature Reviewed

Appendix I - Report of New Technology.

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PREFACE

Public Law 95-208 enacted on December 1, 1977 (91 Stat 1477) directs the Secretary of Transportation, "... to the maximum possible extent, encourage the development and use of intermodal transport, using containers constructed to facilitate economical, safe and expeditious handling of containerized cargo without intermediate reloading while such cargo is in transport over land, air and sea areas."

As part of its overall assessment of the potential of a domestic container system, the Office of Facilitation in the Transportation Programs Bureau of the Research and Special Programs Administration, U.S. Department of Transportation (DOT), acting through the Transportation Systems Center (TSC), authorized this study to evaluate the technological constraints, independent of institutional barriers.

On the basis of the contractor's expertise, and in coordination with the TSC Technical Monitor, the study delineates current and potential problems to the unimodal and intermodal acceptance of a domestic container system possessing multimodal characteristics. The report identifies how further research, in combination with industry participation, can remove these constraints without major disturbance to existing investments in the transportation industry.

The work reported herein was completed under the direction of the TSC Technical Monitor, William C. Spaeth. The research for this report, and its final preparation were the responsibility of Bert A. Bodenheimer. Research contributing to portions of the report was performed by Phillip D. Ohl and Robert Nelson.

John T. Norris, of the DOT Research and Special Programs Administration, provided invaluable guidance during the course of the program.

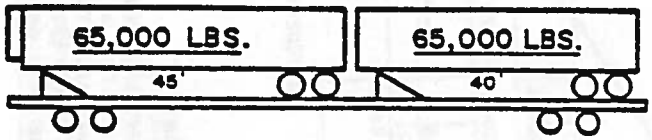
CONTENTS

APPENDIX A

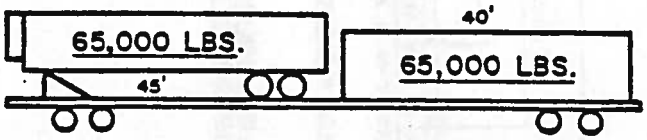
RAILROAD FLATCAR DATA

The following information was received from Trailer Train Company, Chicago, IL., and is reproduced herein with their permission.

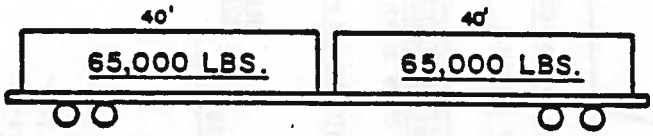
MAXIMUM TRAILER AND CONTAINER LOADS ON 89 FT. STD. DECK T.T.X. FLATCARS



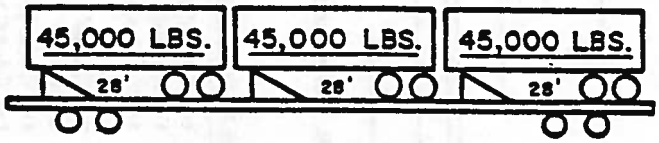
TWO TRAILERS - ONE 45' LG. & ONE 40' LG.



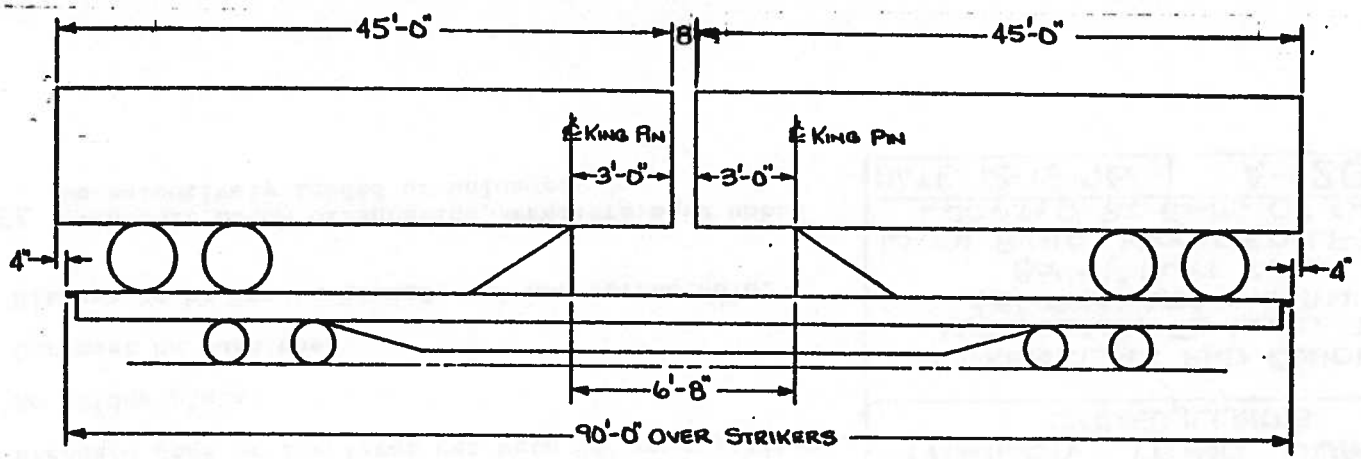
ONE TRAILER 45' LG. - ONE CONTAINER 40' LG.



TWO CONTAINERS - 40' LG.



THREE TRAILERS - 28' LG.



NECESSARY CONDITIONS

1. Trailers must have 36" kingpin spacing.
2. No front-mounted refrigerator unit on trailers.
3. Cars are to be loaded and unloaded by overhead cranes only.
4. Hitches to be oriented as shown except top plate to be reversed(kingpin slot openings to face end sills).
5. Standard deckor low level car with 90' over strikers
6. No bridge plates.
7. Car must be cushioned.
8. Hitches to be non-cushioned, and non-retractable.

NOTE: With this hitch orientation, trailers need not be selectively loaded or unloaded.

TRAILER TRAIN COMPANY CHICAGO , ILLINOIS	
DIMENSIONS AND CONDITIONS NECESSARY TO LOAD TWO 45' TRAILERS ON AN 89'-4" FLAT CAR WITH RIGID, MODIFIED LP-3 HITCHES (LOCATED AT CENTER OF CAR WITH TOP PLATE REVERSED)	
DATE: 4-19-76	A-1904

APPENDIX B

CALCULATIONS

1. CALCULATION OF CONTAINTER/CHASSIS TARE WEIGHT RELATIONSHIPS

Reference 1) Fruehauf Corporation, Letters September 5, 1979 and September 19, 1979.

2) Fruehauf Drawing B-CE 9288, FBZ Closed Top Van (TOFC) 96 inches x 102 1/2 inches x 40 foot long

3) Freuhauf Drawing B-CE 8866, FB Closed Top Van 96 inches x 102 1/2 inches x 40 foot long

4) Freuhauf Drawing B-CF 0488, KAR 6-40 Container 96 inches x 102 inches x 40 foot long

5) Freuhauf Drawing B-CF 0369, Container Chassis NBF-F2-40'.

2. COMPARISON OF GRAIN SHIPMENTS IN CONTAINERS AND HOPPER RAILROAD CARS

Tare Weight Summary
(Pounds)

	40 Foot Highway Van	40 Foot TOFC Van (FBZ)	40 Foot Container & Chassis KAR 6-40 & NBF-F2-40	Potential Domestic Center
Tare Weight	10,535	11,175	12,867	12,867
Less:				
1) deflection criteria for container	-	-	-	(-)815
2) Racking criteria	-	-	-	(-)113
3) ISO Corner Casting	-	-	-	(-)177
4) Six (6) high stacking post	-	-	-	(-)281
Tare Weight	10,535	11,175	12,867	11,481

Difference Between:				
TOFC Trailer &		11,175		
Highway Trailer		(-) 10,535		
		640		
ISO Container/Chassis &			12,867	
Highway Trailer			(-) 10,535	
			3,332	
Potential Domestic Container				11,481
& Highway Trailer				(-) 10,535
				946
Potential Domestic Container				11,481
& TOFC Trailer				(-) 11,175
				306

Investment Comparison per 100 Tons of Grain

Investment

(Dollars)

Item	Covered Hopper	40 or 45 Foot Containers	27 Foot Containers	20 Foot Containers
Car	42,000	2 1/2 @ 52,000 = 130,000	1 2/3 @ 52,000 = 86,666	1 1/2 @ 52,000 = 78,000
Containers	0	5 @ 6,000 = 30,000	5 @ 5,000 = 25,000	6 @ 4,200* = 25,200
TOTAL	42,000	160,000	111,666	103,200

---

* Six containers would have to be used due to gross weight carrying capacity of flatcars.

APPENDIX C

RECORD OF TELEPHONE CALLS

To: R. Dorn
Xentex Corp.
Manchester, NH
603-669-9835

22 August 1979

Dorn was reached at the plant in Manchester, New Hampshire. He stated that he did not have much time to spend since, as manager of the plant, he was one of the few people left; the plant was being permanently shut down.

Xentex panels for container and truck construction are light weight, have good insulating properties, and according to Dorn, cannot be produced to be cost-effective compared with traditional materials. After a survey of the market, and demonstrating the producibility of the panels, Exxon Corp., parent of Xentex, decided to close the plant.

It appears that truckers were not willing to pay the cost to achieve the weight saving.

To: Tony Petriccari
Secretary
Intermodal Equipment
AAR
Washington DC
202-293-4000

24 August 1979

We discussed the total number of railroad flatcars suitable for TOFC/COFC. The data given in "The Official Intermodal Equipment Register" is a total of owned and leased equipment. We requested available data on breakdown of owned equipment.

Petriccari established 7000 units as approximate total of all owned equipment, mostly owned by Santa Fe Railroad.

To: Allen Van Dynne
Raygo Warner
Elk Grove IL
312-593-8987

31 October 1979

We requested information on number of gantry cranes, straddle carriers, and piggypackers in service in U.S.

Van Dynne furnished the following information:

Equipment	Marine	Railroad
Gantries	0	0
Straddle Carriers	4	0
Piggypackers	70	130.

APPENDIX D

INDUSTRY INTERVIEWS

To reflect recent developments, and also to gain insight into the perceptions, attitudes, and reactions of key firms and individuals to container technology applied to a domestic freight system, interviews were arranged with various companies.

This appendix contains a short narrative summary for each interview conducted as part of the study. Each firm or individual was selected according to the criteria listed below; all were expected to experience the impact of containers in some fashion.

Due to limited resources, care was taken to restrict interviews to the smallest sample necessary to be consistent with adequate results. The knowlege and background of the study team was put to use to develop leads with specific industry segments. Certain segments of the industry were excluded from interview because the study team decided that their own background and expertise were sufficient. Accordingly, interviewee-selection methodology was as follows:

a. The interviewee would have an interest in containerization, or feel the impact thereof.

1) One of the modes affected:
   Rail carrier
   Motor carrier
   Water carrier
   Air carrier.

2) The firm would be a potential user of a container system:
   Shipper
   Underlying carrier use (UPS or U.S. Mail)
   U.S. Military.

3) The interviewee has a Governmental interest in containerization:
   Maritime Administration
   Federal Railroad Administration
   U.S. Department of Transportation
   U.S. Department of Agriculture.

The study team initially interviewed the intermodal group of the American Trucking Association which gave a generalized overall picture in regard to trucker attitudes and reactions. The Oneida Trucking Company was determined to be one of the truckers which has handled a considerable volume of intermodal containers. It has specialized to the extent that it has purchased equipment to transfer 20-foot-long marine containers to and from 40-foot chassis. As a result, the study team's interview with Oneida proved very helpful.

e. Interviews with water and air carriers were not judged to be necessary at this stage of the program. The study team believed that a literature search and the background and knowledge of study team personnel provided sufficient input at this time.

f. Shippers and other current or potential users of domestic intermodal transportation provided additional valuable insight. Sears Roebuck was selected because of its large and far-flung operations; also because the character of its traffic rendered it very suitable for intermodal carriage.

UPS, which has the attributes of a carrier, as well as a shipper, was selected for similar reasons, as well as the fact that UPS has acquired substantial amounts of line-haul equipment.

Charter Oak Shippers Association was selected because it is a shippers' cooperative which represents a large group of shippers for which it does consolidations and makes line-haul arrangements. As a result, Charter Oak provided information in regard to many large shipper's problems.

Mobil Oil Company was selected because in addition to its being a large shipper, it currently uses a 20-foot container system in its domestic distribution.

The U.S. Department of Defense was interviewed because of its obvious interest in the defense capability of a transportation network.

The U.S. Department of Agriculture was interviewed because of its obvious interest in agricultural transportation.

g. In addition to the technical data assembled and covered elsewhere, key suppliers of intermodal equipment were interviewed. The Freuhauf Corporation was selected because it is the largest supplier of highway trailers and containers in the U.S., as well as being a builder of container-handling equipment.

The Strick Corporation was selected because it is also a large supplier of highway trailers and containers, as well as being an early innovator in intermodal transportation equipment.

Interpool was selected because it is a leasor of trailers, containers, and chassis to all modes.

INTERVIEW 1

CHARTER OAK SHIPPERS COOPERATIVE ASSOCIATION, INC.

Background

The study team interviewed J. R. Abbey, Executive Vice President. Charter Oak is a shippers cooperative with more than 200 members, including major companies, such as U.S. Steel and General Electric. Charter Oak's primary activity is to consolidate LTL shipments and to assemble shipments and make arrangements for rail TOFC service.

Container Potential

Charter Oak acknowledges that a domestic container system might provide superior economics, but requires that the equipment must be equivalent to a highway trailer. For Charter Oak's operations, which are primarily pickup and delivery to and from terminals and consolidation points.

Size and Weight

Charter Oak indicates that the majority of its shipper members request 45-foot 13'6" high trailers although they believe that with careful planning, a large amount of shipments could probably be handled with 40-foot trailers. In their opinion, the shippers request 45-foot equipment because it is the largest available, and then they will not have a loading problem. Charter Oak refuses to handle 20-foot containers because of high over-the-road cost, and prefers not to use 27-foot trailers because they take up too many bays at terminals.

Container Problems

As indicated above, the use of containers would not prove to be a problem to Charter Oak because they would treat them as trailers. They do not believe that they, or their shipper members, would desire to uncouple containers from their chassis during the time the containers were in their possession.

Future

Charter Oak would agree to support a domestic container system if the equipment were generally equivalent to current trailers while in their possession, and if they offered superior economics for multimodal use. As evidence of this, they indicate their early support of the "Flexivan" system when in use by the former New York Central Railroad. They found the equipment to be satisfactory

INTERVIEW 2

MOBIL OIL COMPANY

Background

The study team interviewed F. Kacher of the traffic department. Mobil is of course a large multinational oil company with many diverse operations. Mobile was selected to be interviewed because it currently uses 20-foot containers in their domestic distribution system.

Container Potential

Mobil sees a potential for containers, particularly for smaller sizes. In this case, the containers can be put together two or more on a large chassis for economical over-the-road operation, and split apart to two chassis for delivery to customers which cannot take truck delivery. This is also, particularly important when operating in older areas such as Manhattan and Brooklyn where longer trucks have difficulty gaining access.

Size and Weight

Since Mobil's products are quite dense, such as case and drum "lube" oil, vehicles greater than 20 feet in length are not needed. They find the present 40-foot container also acceptable, however, except in cases where access is a problem.

Container Problems

Mobil currently operates 20-foot Strick Tainers®. The units look like 20-foot containers, each on their own single axle. Two units can be "married" together, and then the axle from the front unit is moved rearward to a position similar to that on a tandem axle chassis. The unit is then moved over the road as a 40-foot trailer to an intermediate point where it is broken in two for final delivery. This is not a true container/chassis system.

As indicated earlier, this solves Mobil's problem of making small deliveries, particularly to older congested areas, but they view the solution as difficult and costly. Maintenance and operation of the Strick Tainers® are very costly. Mobil is slowly phasing out their use. They are encouraging customers to take larger shipments. They are finding that they are now able to move 40-foot equipment to more and more customers as highway access improves.

INTERVIEW 3

SEARS, ROEBUCK AND CO.

Background

The study team interviewed D. Johnson, General Traffic Manager. Sears Roebuck is a major retailer with many far-flung operations. Sears' TOFC volume alone is estimated to exceed 100,000 vans per year. Sears uses every mode of transportation and virtually all types of equipment; because of the character of their freight and service requirements, they are particularly interested in intermodal developments.

Container Potential

Sears being a shipper would not expect to operate equipment for the most part. To the extent that Sears does, they would like the units to behave as a truck. Their interest in containers, therefore, is that they improve carrier economics so that Sears can in turn benefit from the enhanced cost and service.

Size and Weight

All of Sears' facilities are constructed to accommodate 13'6" trucks. Sears also requires high trailers for shipping household refrigerators. As such, Sears would prefer to have any domestic container system conform to their requirements. In regard to other dimensions of the equipment, Sears leaves the decision up to the carrier which they believe is in the best position to make cost/service comparisons and trade-offs.

Container Problems

Sears' main concern with a container system was the oft-repeated problem of chassis supply and control. They believe that if this was not properly handled, the unit could cause service problems particularly at railroad terminals. Other than this, Sears, since they intended to treat a container and chassis in their possession as a trailer, saw few problems.

Future

As indicated above, Sears was not primarily concerned with the type of equipment carriers selected as long as the van and/or container came to them on wheels and looked like a truck; after these requirements are met, Sears main consideration was the cost and service offered by the carrier.

ontainer Problems

UPS is somewhat reluctant about the idea of introducing containerization o railroads. They believe that it would only cause deterioration in rail ser- ice; they do not believe that railroads could handle the chassis problem.

UPS cannot see any advantage to separating a container from a chassis hile in their hands. In fact, they are completely opposed to the idea. They ant a box to be ready to go as soon as loading is completed, and believe that o matter how quickly a container can be united with its chassis, the time is nfinitely longer than just closing the doors of a trailer. To them, the time no matter how small) is critical.

uture

As such, UPS remains to be convinced that any advantages that containers ight have for rail operations could be translated to saving for them while aintaining service standards. They see no advantage at all to containers in heir over-the-road and terminal operations.

INTERVIEW 6

CONRAIL

Background

The study team interviewed J. Cunningham, Intermodal Services, Conrail. As indicated earlier, Conrail was selected because they are so large and serve a large portion of the United States. Conrail presently has extensive TOFC and COFC operations. Conrail is looking to rationalize their operations; current box-car traffic is about 20 percent of their revenue, but contributes only about one percent of the profit. Therefore, Conrail will try to switch some of the boxcar traffic to trailers. Currently, box cars and trailers are imbalanced in opposite directions.

The preponderence of traffic is in unit trains. Conrail is returning to the concept of a few highly automated central points - they require about 2,500 units/month to justify a piggypacker. Currently Conrail is developing the numbers to determine how many terminals there will be. It may well be that the Conrail intermodal presence may be truck, rather than rail.

Container Benefits

On a purely intuitive basis, Cunningham feels a container system is better than TOFC, probably due to marine influence. Lifting is the important part of the equation. A time cycle of two minutes is a good rule of thumb. Conrail, at the 47th Street Yard (Chicago) and in Philadelphia, have cranes rather than piggypackers.

Container Problems

The major problem is handling containers and TOFC together. If containers and TOFC are mixed randomly, then the raising and lowering of stanchions is required, a very time-consuming process. Conrail cannot afford to cut and replace cars as needed.

Conrail has designated certain facilities as COFC; at facilities not so designated, container traffic is subject to charges for cranking stanchions. The charge is $20.00 per car, with a 50-car minimum, or $1,000. This is to discourage random COFC.

At container and other facilities, Conrail has instituted a charge of $41.00 for grounding COFC. This has tremendously improved chassis availability from steamship companies.

INTERVIEW 7

ILLINOIS CENTRAL GULF (ICG) RAILROAD

ıckground

The study team interviewed Peter Novas, Vice President of Intermodal ırvices. The ICG is a large midwestern railroad running north-south through ıe midwest of the United States. It parallels the Mississippi river system ıtween Chicago and New Orleans. The ICG presently handles marine containers ı part of their domestic TOFC system. ICG has found the empty movement of .rine containers to be a big problem, even where empty equipment of the same ıeamship company makes cross moves. As a result, ICG has imposed an empty-ıturn charge for marine containers. They have, however, evolved a system to y to find return loads for equipment if the ocean carrier is not able to find .e. They will also move equipment to central locations where they believe a ad will be found and charge the steamship company only for the empty mileage.

ntainer Benefits

The ICG is aware of the potential of containers to railroads, and is cur-ntly reviewing many systems including the "Road Railer ®". They believe that ncerted action with other railroads would be required at this time to make y new system work because ICG interchanges with other railroads. Because ICG lieves this is impossible, they are working toward interchanging less with other rriers, and increasing their single-line traffic. When most of their traffic handled wholly within their system, the ICG will select an intermodal system.

ze and Weight

ICG believes that the current 40-foot 13-foot six-inch piggyback trailer ll continue to be the standard for at least five more years, and is currently rchasing large quantities of this equipment.

ntainer Problems

ICG believes the largest problem in dealing with containers is the chassis. ey perceive both a lack of standardization and a lack of interchangeability chassis. If these problems could be solved, ICG believes that COFC would be-me attractive because they have lifting capability in their major terminals.

ture

As indicated earlier, ICG is aware of the potential benefits of contain-ization and plans on adopting some form of system within the next few years.

INTERVIEW 9

ONEIDA TRUCKING

Background

The study team interviewed W. Hassek, General Traffic Manager. Oneida is a moderately large regional motor carrier with operations in NY, NJ, and PA. As such, Oneida handles a considerable number of containers from Rochester with Eastman Kodak's export shipments making up a large portion of them.

Container Benefits

Oneida has modified their operation to handle containers because of the traffic opportunity. In all cases they view containers as being more costly than conventional highway trailers; they handle containers because, as in the case of Kodak, the shipper pays the additional costs. Oneida can see no benefit to separating a container from a chassis at a customer's facility. At their own terminals Oneida has Stedman transfer devices for the purpose of getting access to the doors of 20-foot containers while on a 40-foot chassis. Except for the transfer mentioned above, Oneida keeps containers on chassis at all times. Oneida believes that containers might prove to be helpful to operators that use small trailers for city pickup and delivery. They believed that containers would not help Oneida however, because Oneida's operation is based upon the use of straight trucks for local pickup and delivery. Oneida uses straight trucks for this purpose because their analysis shows a straight truck's operating cost to be less than a tractor alone, exclusive of a trailer.

Size and Weight

Oneida does not favor the use of 20-foot containers because of the loss of cube; it is willing to operate them, however, as indicated above, if the freight is attractive enough to overcome this disability. Oneida's preference is generally for the largest piece of equipment that can be operated legally over the road. They believe, however, that the 45-foot trailer is the maximum practical size due to operating problems encountered with longer trailers.

Container Problems

As indicated above, Oneida views containers as cube-limited and costly to handle. As such, they believe that containers are mostly problem-creating, with little or no benefit. Oneida handles containers only because without them they would have to forgo certain traffic.

INTERVIEW 10

SANTA FE (SFE) RAILROAD

ackground

The study team interviewed Martin Breischiki, Traffic Manager for Inter-odal Services. The SFE is a major transcontinental railroad which has made major commitment to serving the intermodal market, most notably from Chicago o Los Angeles and San Francisco. SFE has also designed and built new and ighly efficient equipment such as the *Ten Pack*® rail-car to serve this arket.

ontainer Benefits

The SFE acknowledges the many benefits of containerization and believed he problems discussed below were overriding.

ize and Weight

The SFE believed that the 40-foot by 13-foot-six inch trailer will con-inue to be the standard for the near future, and that there always will be ome market for this size. It is important to note, however, that the new quipment SFE is building, such as the *Ten Pack,* can and does handle 45-foot :ailers.

ntainer Problems

SFE perceived similar problems to containers as other railroads; i.e., ack of availability of chassis. The SFE also believed that, at the present :ate of the art, control technology was not available to track and control quipment through the complex inter-line movements currently in use.

ture

SFE acknowledges the potential benefits of containers, but will have to convinced that the technology for solving chassis availability is devel-ed. They will also have to be convinced that connecting carriers will begin adopt a container system before they themselves agree to containerization.

Future

As indicated above, the Southern is evaluating several alternatives for improving its intermodal operations. After having pioneered with containers, however, and failing to gain industry acceptance, they prefer to play a waiting game. The Southern also believes that it has superior investment opportunities in areas other than intermodal, and as a result, would prefer to concentrate on these. Southern very strongly feels that *any* development of a container system must be done in the context of an awareness of the large railroad investment in conventional TOFC flatcar equipment.

INTERVIEW 13

STRICK CORPORATION

Background

The study team interviewed Sol Katz, Chairman of the Board of Strick. Strick is one of the largest manufacturers of highway trailers and marine containers. Strick was also the builder of Flexivan (R) equipment. Flexivan was one of the first successful intermodal systems which operated satisfactorily on the former New York Central Railroad. Despite this, the system failed to gain widespread acceptance by the railroad industry in general because of problems other than the underlying technology.

Container Potential

Strick believes that there are many technological approaches which could readily provide a viable domestic container system. Strick further believes that management inertia and lack of clear common perception and goals on the part of the railroad industry will prevent adoption of a superior system. As a result, Strick believes that conventional TOFC will continue to be the dominant method for domestic intermodal operations for the forseeable future.

Size and Weight

Strick has no precise idea of what will evolve in regard to equipment size. They believe that shipper and carrier preference will continue to be for the largest piece of equipment which can be legally operated.

Container Problems

As indicated above, Strick does not perceive any particularly large problems with containers. They believe that the main problem lies with lack of a uniform position on the part of industry.

INTERVIEW 15

EQUIPMENT INTERCHANGE ASSOCIATION

Background

The study team interviewed K. Hauk, who heads the Equipment Interchange Association. He has broad experience in trucking as well as in container operations. Hauk is a member of the ANSI MH5 Freight Container Committee.

Container Potential

Hauk stated that in his opinion container potential was substantial if certain problems can be overcome. The marine constraints should not be superimposed on a domestic system. For example, a practical loading weight for domestic service is not 30 tons since a TTX car cannot take two 30-ton containers. (This conflicts with TTX published data.) Marine containers are still essentially a port-to-port device, and penalizes all inland modes.

A domestic container system will ultimately affect the offshore marine system, the U.S. should take the lead in this.

The potential of a container system is especially great where trade lanes are unbalanced, and the rails can handle empty containers efficiently, rather than using the highway mode.

Size and Weight

There is a point at which size increase no longer has an economic value. The U.S. may ultimately go to 70- to 72-foot length overall, which makes two 30-foot trailers possible. Two 40-foot trailers are too long. A 65-foot uniform length is probably enough right now; i.e., one 45-foot long unit.

Any cubic capacity is important. There is insufficient coordination among package sizes, pallet sizes, and manufacturers. Relaxation of weight laws will help greatly, but the biggest problem is the lack of uniformity.

Unimodal Use

A major problem is taking the box (i.e., container) off the chassis at the shipper's facilities. Large shippers, and therefore large truckers, see TOFC as most efficient because of speed of loading (no transfers). One chassis to serve one container will prevail unless the unit can be dropped inexpensively. Until costs come down, operations will stay container on chassis in highway operations.

INTERVIEW 16

NASA LANGLEY RESEARCH CENTER

Background

The study team interviewed R. Bancom, NASA, Materials Branch, Langley VA, to obtain current information on the possibility of using space-age materials in container or chassis construction. In addition to discusssion of the various possibilities, Bancom showed us various aircraft components, such as tail surfaces, now using composite material structures.

Composites

Composites offer tremendous weight reduction resulting in lucrative benefits in aircraft operating cost. Graphite-reinforced systems cost in the range of $10.00 to $20.00 per pound; they are cost-effective in aircraft structures where a rule of thumb is that light-weight materials can cost up to $60.00 per pound. For the forseeable future, the cost of the graphite composites is not likely to come down.

Kevlar-reinforced systems, in the $5.00 to $10.00 per-pound range are probably the best opportunity. Kevlar is one-sixth the weight of steel, and has a tensile strength of 180,000 to 200,000 psi with a linear stress-strain curve. Kevlar is used in mooring ropes, netting, armored cars, executive cars, and bullet-proof vests, and in automobile tires. For chassis materials the Kevlar fibers can be oriented by the pulltruding process, a combination of extrusion and pulling. One of the large manufacturers is Morrison Molded Fibre Glass Co., Bristol VA. The materials are easily repairable and have good impact resistance. The price is likely to stay high since DuPont has a lock on the market.

Finally, there are the fiberglass materials in the $1.00 to $2.00 per-pound range. These are of course already in use in containers and trucks.

INTERVIEW 18

U.S. DEPARTMENT OF COMMERCE - U.S. MARITIME ADMINISTRATION

Background

The study team interviewed R. Corkery, Program Manager, Research and Development. The Maritime Administration is interested in developing and promoting domestic off-shore and coastwise and intercoastal shipping as well as foreign shipping for which U.S. Maritime Administration (MARAD) is better known. Corkery was designated as MARAD's contact for the purposes of this project.

Container Potential

Marine applications have been among the earliest in container development. The ocean mode is the least limiting of all the transport modes, and Corkery believes that if an efficient rail-highway system can be perfected, that the marine system can easily accommodate itself to whatever is developed.

Size and Weight

As indicated above, the highway mode is the most limiting in this regard with rail somewhat less so; after the requirements of these two are determined, the marine system will easily adapt itself to the overall needs.

Container Problems

The Maritime Administration cannot identify any particular problems, with regard to adopting a domestic container system to marine use.

Future

As indicated above, the domestic water-transport system is already a major user of container technology. There would be no particular problem in further adapting marine systems to handle an improved domestic container.

APPENDIX E

FIELD TRIPS AND CONFERENCES

CONRAIL KEARNEY NJ

TOFC Terminal

In addition to interviewing key Conrail executives, the study team scheduled a field trip to Conrail's Kearney facility. Kearney handles both TOFC and COFC and the trip was scheduled so as to permit viewing of both methods of handling.

The study team proceeded to the Kearney yard on 28 September 1979, and met with R. Ascensid, Conrail Regional Manager and H. Sakow, Terminal Manager for Pennsylvania Truck Lines, the Conrail trucking subsidiary. The yard is fairly representative of a large railroad TOFC/COFC facility. Kearney has a modernized entrance with two entering lanes and two exit lanes. The yard is fairly well paved and has parking for about 1,700 trailers. Kearney operates exclusively with side-loading equipment (piggypackers).

The study team immediately proceeded to view the unloading of TV 12, the Conrail weekly container train from the west. After this, the unloading of a TOFC train and the loading of a TOFC train was observed. Exhibits I, II and III show detailed times recorded along with appropriate comments.

In general, it can be stated that the COFC operation took longer than TOFC. This was caused primarily by waiting for chassis; with a better chassis supply and with improved organization and methods, the cycle time for both (TOFC/COFC) would probably be identical.

Otherwise, the trip to this facility proved to be very helpful to the study team in that it showed at first hand some of the day-to-day problems encountered in a high-volume rail TOFC/COFC facility.

EXHIBIT II

Trailer (TOFC)

Total Cycle Time to Unload Six Trailers = 12 min 30 sec

Previous Trailer 0 to Trailer 1	@	0 min	10 sec.
Trailer 1: Contact with Ground	@	0	35
"Packer" in Position for Trailer 2	@	1	40
Trailer 2: Contact with Ground	@	2	38
"Packer" in Position for Trailer 3	@	3	50
Trailer 3: Contact with Ground	@	4	38
"Packer" in Position for Trailer 4	@	7	12
Trailer 4: Contact with Ground	@	8	04
"Packer" in Position for Trailer 5	@	9	15
Trailer 5: Contact with Ground	@	10	10
"Packer" in Position for Trailer 6	@	11	28
Trailer 6: Contact to Ground	@	12	30.

Note: King-pin locking device on flatcar can hang up, thus stretching out cycle.

U.S. DEPARTMENT OF DEFENSE

Container Utilization Workshop

Background

The study team attended the DOD Container Utilization Workshop held on 11 December 1979 at Washington DC. The workshop was held under the sponsorship of the Joint Intermodal Steering group (JISG) to exchange information and discuss basic container utilization issues. The workshop was directed by the Intermodal Coordination Group (ICG). The purposes of the workshop were to review present automated container shipment planning systems of the military services and the Defense Logistics Agency, examine container utilization reporting procedures, and set goals to achieve improved container utilization.

Highlights of the Discussion

1) The military uses containers for overseas shipments paying for the containers on a volume basis; i.e., a fixed sum per load. Thus, the higher the cube utilization of each container, the more efficient the transport.

2) Offsetting the savings that result from maximum cube utilization are the length of time a container must be held to accumulate a full load to a single consignee (inventory costs), single versus double consignee delivery costs, etc.

3) Each of the services now has, or shortly will have, systems in place to monitor cube utilization and to achieve a high rate.

4) Inland transportation costs of 20-foot equipment are higher than for 40-foot equipment. A 63-percent cube utilization in a 40-foot container generally breaks even with a 75-percent utilization in a 20-foot container.

5) Only about 10 percent of all loads are weight-limited.

6) The use of material handling equipment for loading and unloading containers also reduces cube utilization. For example, while it is theoretically possible to place small packages around a machine component, the cost of individually handling the packages at both ends, compared with pallet and fork-lift operations, is prohibitive.

AGENDA

INTERMODAL TECHNOLOGY CONFERENCE

MONDAY, OCTOBER 8, 1979

CHICAGO, ILLINOIS

9:00 AM	CONFERENCE REGISTRATION (Coffee and Rolls Served)
10:00 AM	WELCOME REMARKS
	Conference Objectives, Procedures and Schedule Survey of Representation
10:15 AM	GOALS OF FEDERAL RAILROAD ADMINISTRATION FREIGHT PROGRAMS
	Technology for Efficiency, Improved Service, Safety and Viability
10:30 AM	THE INTERMODAL SYSTEMS ENGINEERING PROGRAM
	Background, Objectives and Status
10:45 AM	PROGRAM STRUCTURE AND PARTICIPANTS
	Contractual Relationships, Interviews and Case Study Railroads
11:00 AM	THE MARKET TO BE CAPTURED
	Service Sensitivities, Growth Forecasts and Strategies for Penetration
12:00 Noon	LUNCH
1:00 PM	THE STARTING POINT
	Today's Intermodal System as the Baseline
	Performance and Cost Characteristics of the Terminal Linehaul and Pick-up/Delivery Sub-systems
	The Simulation and Cost Models Developed to Analyze Present and Future Systems

AGENDA

TUESDAY, OCTOBER 9, 1979

8:30 AM	ALTERNATIVES IN EXISTING EQUIPMENT
	Scanning the Domestic and Foreign Marketplace
	Variations in Types, Performance and Costs
9:00 AM	INTERMODALISM IN EUROPE
	Ahead, Behind or Just Different?
	(Slides and Movies from August 1979 Inspection Trip)
10:30 AM	BREAK (REFRESHMENTS)
10:45 AM	BUILDING AN EFFICIENT INTERMODAL SYSTEM
	Choosing the Right Equipment and Designing the Terminals
	The Evaluation Procedures Employed
12:00 Noon	LUNCH
1:00 PM	A LOOK TO THE FUTURE
	Improved Intermodal Systems for the Near Term
	Innovative Systems for the 1990's and Beyond
1:45 PM	EVALUATION STRATEGIES FOR INNOVATIVE SYSTEMS
	Methods for Dealing with Uncertainties in Both Requirements and Technology
2:15 PM	IMPLEMENTATION OF INTERMODAL SYSTEM IMPROVEMENTS
	Criteria for Successfully Accomplishing the Critical Final Step
3:15 PM	BREAK (REFRESHMENTS)
3:30 PM	SUMMARY AND CONCLUSIONS
	Review of Key Points Presented and Their Implications

APPENDIX F

ANNOTATED BIBLIOGRAPHY

A. T. Kearney, Inc., and Peat, Marwick, Mitchell & Co., "Systems Engineering for Intermodal Freight Systems - Phase I, Exploratory Planning Volume I - Executive Summaries," FRA/ORD-78/24.I, Washington DC (April 1978)

An overview of the findings of the initial phase of the Federal Railroad Administration (FRA) Intermodal Systems Engineering Program is presented. The work reported presents one segment of FRA-sponsored research and development directed to the improvement and viability of rail-freight service.

Phase I, Exploratory Planning, Systems Engineering for Intermodal Freight Systems, briefly stated, included: (1) characterization of present intermodal equipment and operations, (2) identification of problems or opportunities where technology could be utilized to improve service, efficiency, and return on investment (3) identification of improved equipment, subsystem, facility concepts having potential future application, (4) synthesis of alternative systems made up of improved equipment in various combinations, (5) development of methodology for assessment of the relative merit of system alternatives in quantitative terms under various operating scenarios, and (6) evaluation of synthesized systems and identification of most promising alternatives.

The work reported was performed by two contractor teams working independently, each using slightly different approaches. Each contractor interacted with intermodal committees of the Association of American Railroads, the Transportation Research Board, and the National Industrial Traffic League. The findings from Phase I are to be used in a more in-depth examination of the most promising alternatives during Phase II, Development Planning.

Shonka, D. B. A. S. Loebl, and P. D. Patterson, "Transportation Energy Conservation Data Book: Edition 2," ORNL-5320, Oak Ridge National Laboratory, Oak Ridge TN (October 1977)

This document is the second edition of the Transportation Energy Conservation Data Book, a statistical compendium compiled and published by Oak Ridge National Laboratory (ORNL) under contract with the Transportation Energy Conservation (TEC) Division of the Energy Research and Development Administration (ERDA). Secondary data on transportation characteristics by mode, on transportation energy use, and on other related variables are presented in tabular and/or graphic form.

All major modes of transportation are represented: highway, air, rail, marine, and pipeline. The six main chapters focus on various characteristics of the transportation sector including (1) modal characteristics, (2) current

5. Reebie Associates; Urba, C.E., et al. "The Railroad Situation - A perspective on the Present, Past and Future of the U.S. Railroad Industry," FRA-OPPD-79-7, Greenwich CT (September 1978)

This study was undertaken for the Federal Railroad Administration in partial compliance with Section 901 of the Railroad Revitalization and Regulatory Reform Act of 1976. Section 901 directs the Secretary of Transportation to "conduct a comprehensive study of the U.S. Railroad Industry."

This study provides an overview of the U.S. railroad industry. It describes the present situation and explains how the present situation evolved, concentrating primarily on the period 1929 - 1976. The likely future of the railroad industry over the next ten years is evaluated. The study concludes with a summary of how "The Railroad Situation" is currently viewed by railroad management, railroad labor, shippers, and other concerned parties.

. Environmental Design and Control Division, Offices of Research and Development, Federal Highway Administration, Winfrey, R. et al. "Economics of the Maximum Limits of Motor Vehicle Dimensions and Weights," FHWA-RD-73-69, Washington DC (September 1968)

Determining the desirable maximum limits of dimensions and weights of motor vehicles is approached on the basis of highway cost and the operating cost so far as the factors of economy are concerned. Axle weight, gross vehicle weight, and vehicle length are analyzed on the basis of six highway systems consisting of the rural and urban systems within the interstate, primary and secondary highway systems. The analysis is based on data and truck weight studies conducted in 46 states; operating cost data obtained from truck fleet operators; and experimental data on pavements and bridges obtained from the comprehensive AASHO road test.

The desirable limits of dimensions and weights for use were found to be the following:

1) Vehicle height of 13.5 feet

2) Vehicle width of 102 inches

3) Maximum lengths on all highways of 40 feet for single-unit trucks and trailers, 55 feet for tractors and semitrailers, and 65 feet for any other combination of vehicles.

4) Axle weight limits of 22,000 and 38,000 pounds for single and tandem axles, respectively.

5) Gross weight limit of at least 120,000 pounds, or better yet, no gross weight limit at all with control of axle weight and spacing.

9. Kenworthy, M., "Transportation of Vibration Sensitive Equipment by Highway Trailer on an Intermodal Railcar - Vol. I," FRA/ORD-79/05-1, Alexandria VA (July 1979)

This report includes the results of a cooperative research project between government and industry to explore the potential for the use of highway trailers on intermodal railcars (Trailer on Flatcar) or (TOFC) to transport vibration-sensitive lading. The industrial participants in the study were the Boston and Maine Railroad, the Digital Equipment Corporation, and Mooney Moving and Storage (representing Allied Van Lines).

The purpose of the project was to characterize the operating environment of TOFC during the transport of vibration-sensitive teletypewriters. To this end, the lading, two types of trailers, and the conventional TOFC flatcar were instrumented to quantify the shock and vibration environment during typical over-the-road revenue operation. The trailers used were a conventional railroad owned leaf-spring trailer and an airride moving van. Various measurements of the accelerations experienced by the lading as well as the TOFC components were taken during the road test. The test was conducted using a special train operating over sections of the main line tracks and yards of the B&M Railroad between Boston and Mechanicville NY. Test equipment, test procedures, and data processing techniques used are discussed in the report. The results of the test indicated that the ride quality of both types of trailers are similar, and that TOFC is feasible for the transportation of vibration-sensitive equipment. Test results contained in the report provide useful information to traffic managers and packaging engineers.

Rose, A. B., "Energy Intensity and Related Parameters of Selected Transportation Modes: Freight Movements," ORNL-5554, Oak Ridge National Laboratory, Oak Ridge TN (June 1979)

A study was undertaken to determine the causes of the divergences among published energy-intensity values and to prepare a set of consistent values. This volume presents the findings in relation to the freight-transporation modes. After a brief overview of the important factors to be considered and the potential pitfalls facing users and analysts of energy-intensity values, each of the major means of freight transportation - air, marine, pipelines, rail, and truck - is discussed. In each of the chapters, after a critique of the available data sources, a consistent time series of operational data and energy intensity values is presented for the major sectors of each mode. In addition, the energy-use effects of the major operational and hardware parameters are quantified so that the given energy intensity values may be modified to reflect a variety of possible changes in the transportation systems. Finally, matrixes giving the great-circle distances and modal circuity ratios among the 50 largest standard metropolitan statistical areas are included to facilitate intermodal comparisons.

The results of this analysis suggest that the best means of achieving nergy saving is probably reliance upon market forces. Individual carriers nd owner-operators will become aware of the potential energy and cost saving rom improved van design, improved refrigeration motor design and operation, nd better insulation, and will be induced to make energy-saving investments. efrigerated trucks are a small component of the U.S. fleet of heavy-heavy rucks (less than 5%), and the energy consumed by refrigerator units is com- aratively small, relative to fuel consumed by the vehicles in over-the-road auling (15%). The demand for refrigerated products continues to grow, imply- ng a larger share of the fuel consumption of all heavy-heavy trucks; if the ndustry improves the insulated van and its accompanying refrigeration motor, he auxiliary power improvements will decrease its disproportionate energy con- umption in the future.

3. U.S. Department of Transportation, Office of the Secretary, Cargo Security Handbook for Shippers and Receivers, Washington DC (September 1972)

Losses resulting from cargo theft and pilferage in the transportation sys- em have been estimated to exceed $1 billion annually. This may well be a con- ervative estimate. Losses of this magnitude constitute a major drain on the ommerce of the United States.

Although losses through theft and pilferage are a common problem where- ver goods are moved or stored, the greater share of these losses occurs at ie ends of the physical distribution process, in shipping and receiving. Such sses are especially detrimental to small business. Their ultimate cost is rne by the consumer and society at large in the form of higher prices, higher surance premiums, and higher costs of remaining in business.

The problem of cargo security is the joint responsibility of shippers, rwarders, carriers, and receivers. Everyone concerned with trade, domestic international, is interested in the delivery of merchandise in sound condi- on and the avoidance of unnecessary economic waste because of loss from theft d pilferage of goods in the transportation system.

This handbook is issued to provide guidance and assistance to management an effort to achieve maximum cargo security for shippers and receivers.

. U.S. Department of Transportation, Office of Transportation Security, "Claims Paid History Motor Carriers of General Freight 1972 through 1976," DOT-P-5200.13, Washington DC (October 1977)

This report summarizes four years of economic data submitted to the Inter- ate Commerce Commission by Class I and Class II Motor Carriers of General eight earning $1 million, or more, in gross operating revenue annually. The mputerized report generation and data analyses were performed by the DOT ansportation Systems Center for the Office of Transportation Security.

c) providing an equitable basis for charging such repairs and damage,

d) inspecting trailers for interchange to be in accord with this Code Rules, and

e) making "Destination Inspection Agreements" with two or more carriers volving the waiving of "Interchange Inspection" not covered by these rules, d settlement of disputes involving damage occurring under such arrangements, be settled in accordance with the terms of the agreement or contract between e parties involved.

- A. T. Kearney, Inc.; "Feasibility of Developing Containerized Transport and Storage System for Grains and Soybeans to Facilitate Use of Wide Range of Transport Vehicles," Chicago IL (June 1975)

Containerized transporting and-handling is one of the recently developed ysical distribution technologies which may afford many opportunities to im- ove the marketing and distributing of various agricultural products. Thus : however, the use of this transporting and handling technique has been gely in the intermodal transport of perishable food products in various types packages. Relatively little use of containerization has been made in the nsporting and handling of bulk agricultural products.

For many years, U.S. producers, shippers, and distributors of food and d grains and soybeans have been plagued by increasingly critical shortages suitable on-and-off farm-storage capacity and an adequate supply of trans- tation equipment to enable prompt movement of the products to domestic users to ports for export. This has been particularly true during the peak har- t months when the flow of the products into the storage and transport sys- s was especially heavy. It has been suggested that some form of containeri- ion might provide an economically feasible solution to these problems, par- ularly since it might facilitate the combining of the transport and short- n storage steps in the physical distribution of the products.

This study was made to assess the engineering, economic, and operational sibility of employing containerization in some form as a partial solution these problems. It is intended to serve as a basis for determining whether ndertake additional research on the problem which would involve development, luation, and demonstration of alternative equipment, systems, and techniques which such containerized transporting and handling might be accomplished. research was done by the firm of A. T. Kearney, Inc., under contract to the icultural Research Service.

A. T. Kearney, Inc., "Feasibility of Developing a Hopper-Bottom Boxcar for Railroad Transportation of Grain and Soybeans," Chicago IL (Nov. 1974)

Grain and soybeans are shipped by railroad in 40- and 50-ton boxcars and red-hopper cars, usually of 100 tons' capacity. In recent years however, owing proportion of both types of products has been shipped in covered- er cars. After unloading at milling or processing centers or ports, the

:0. U.S. Department of Agriculture and U.S. Department of Transportation, "Transportation Services to Meet the Growing Needs of Agriculture: A Preliminary Report of the Rural Transportation Task Force," Washington DC (June 1979)

This preliminary report of the Rural Transportation Advisory Task Force, stablished by Public Law 95-580, addresses issues concerning agricultural ransportation and invites public comment.

Agricultural transportation is in some respects the domain of shipper and arrier specialists - yet all of us produce, consume, or manufacture food and iber. We must become informed about a process that is essential to us, indi-idually, and as a nation. All of us are dependent upon widely separated armers, marketing agencies, transportation firms, and others for our daily ood needs.

It is in this spirit that this report contains considerable information out how agriculture and transportation affect each other. The Task Force has sked for and received information from representatives of various organiza-ons about their transportation operations and problems. All of these organ-ations and individuals shared their insights and concerns. To a large de-ee, this report reflects the knowledge gained from these persons.

. Andrew G. Hammitt Associates; Hammitt, A. G., "Aerodynamic Forces on Various Configurations of Railroad Cars for Carrying Trailers and Containers," FRA/ORD-79/39. Rancho Palos Verdes CA (January 1979)

Toward improving the energy efficiency of rail intermodal service, the rodyanmic characteristics of the rolling stock offer an opportunity for tterment. At speeds above 45 miles per hour more than one-half of the sistance of an intermodal train is caused by the aerodynamic drag of the rs and their loads. Methods by which the aerodynamic drag may be minimized e, therefore, of considerable interest to railroads and car designers.

The report covers the wind-tunnel testing of scale models of railcars r carrying trailers and containers. The purpose was twofold: First, to termine whether differences in the aerodynamic characteristics of such scale iels could be measured in the wind tunnel showing that it could be utilized an evaluation tool in future railcar design programs; and second, to obtain nparative performance data on five new intermodal railcar configurations.

The findings confirm that wind-tunnel testing is a viable design evalu-on method. The cost of this series of tests was about $9,000 for the wind-nnel utilization, about $20,000 for the models plus a nominal amount for the a analysis and report preparation. Compared with full-scale testing, wind-nnel testing, therefore, requires only minimal resources.

APPENDIX G

PATENTS REVIEWED

Patent No.	Date	Patentee	Title
.,993,481	3/5/35	Kellett	Transport Equipment
,053,969	9/8/36	Olds	Cargo Container
,063,033	12/8/36	Fitch	Demountable Body
,310,948	2/16/43	Fitch	Demountable Freight Container
,317,985	5/4/43	Fitch	Demountable Freight Container
,442,459	6/1/48	Fowlder	Cargo Container for Airplanes
,715,951	8/23/55	Cox	Apparatus for Handling Freight
,985,482	5/23/61	Lion	Container for the Transportation of Various Goods
,004,682	10/17/61	Bertolini	Cargo Container
023,918	3/6/62	Penman	Transferable Load Containers
063,667	11/13/62	Doty	Retractable Supports for Cargo
073,466	1/15/63	Greer	Transportation Unit Carrying, Loading and Unloading Equipment
085,707	4/16/63	Tantlinger	Freight Containers Adapted to be Stacked.
092,282	6/4/63	Tantlinger	Automatic Container Tie
116,085	12/31/63	Uttley	Telescopic Trailer
158,106	11/24/64	Clejan	Freight Transportation Systems
162,320	12/22/64	Hitch	Body Member Connecting Mechanism
244,310	4/5/66	Isaacs	Detachable Cargo Body and Vehicle With Elevating Mechanism for Same
260,223	7/12/66	Black	Container Car and Container Therefore
294,419	12/27/66	Martin	Coupling Arrangement for Tandem Axle Semi-Trailers
300,071	1/24/67	Isaacs	Detachable Cargo Body and Vehicle With Elevating Mechanism for Same
59,752	9/3/65	Westling	Refrigerated Containerized Cargo Transport System and Container Therefore

APPENDIX H

LITERATURE REVIEWED

MATERIAL HANDLING, CONTAINER MANUFACTURER'S AND ASSOCIATED HARDWARE

Company	Equipment
Liebherr Crane Corp. Newport News VA	Cranes
Siemens Corporation 186 Wood Avenue South Iselin NJ 08830	Container Terminal Automation Equipment
E. I. Dupont De Nemours Wilmington DE	Kevlar 49 Aramid Fiber
Paceco, Inc. 1320 Blanding Avenue Alameda CA 94501	Terminal Container Handling Equipment, Portainers and Transtainers
Paygo Wagner Equipment Co. P. O. Box 20044 Portland OR 97220	Strad 80 Straddle Carrier, Port Packers, Piggy Packers
Palmar Lagab AE Box 47 S-312 01 Laholm Sweden	Sideloaders, Mini and Maxi Demountable Body System
Marathon LeTourneau Company P. O. Box 2307 Longview TX 75601	Container Handling Equipment Cranes, Straddle Hoist
Modular Distribution Systems of America, Inc. P. O. Box 447 Smithfield VA 23430	Container Handling Equipment, Gantry Cranes, Service Module, Transfer System
J I Case (Drott Division) Box 1087 Wausau WI 54401	Railroad Piggyback, Container Straddle Carry, Container Crane

Company	Equipment
Hilgers, A.G. Postfach 9 D-5456 Rheinbrohl Germany	Portal Cranes for Container Handling
W. R. Stamler Corp. Millersburg KY 40348	Hydraulic Car Spotters and Automatic Loading Stations
J. H. Carruthers & Co., Ltd. East Kilbride, Glasgow, G74 51R Great Britain	Cranes
Magrini Galileo 35041 Battaglia Terme (PD) Italy	Hoisting Equipment, Cranes
Lansing Bagnall, Ltd. 1250 Steeles Ave Bramalea ON Canada	Container Handling Equipment, Side Loaders, Front end machines
Belotti Overseas Liaison Services 505 Park Avenue New York NY 10022	Container Handling Cranes
Ralph Blatchford & Co., Ltd. Midsomer Norton Bath BA3 2AB England	Universal Side Unloader System
BiRail Company P. O. Box 516 Detroit MI 48221	Rolloader ™ System
Pecco Millwood NY 10546	Cranes
The BiModal Corp. 200 Railroad Avenue Greenwich CT 06830	Combined Rail/Highway Trailer.

APPENDIX I

REPORT OF NEW TECHNOLOGY

The work performed under this contract was an assessment of current technology in the field of container design, handling, and use; and thus, by its very nature, did not lead to any inventions. The examination of the present and emerging state of the art led to the identification of problem areas where further research and development activities appear to be warranted.

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