The Public Interest and Course of Action in Optimizing Rail-Highway Transportation

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•GREAT benefits to the general public, and to transportation carriers, can come through an increase in the interchange of freight between modes, with each mode playing the part for which it is most economically suited. Only in this way can the through logistics optimum for our economy be obtained. Progress has already been made in combining rail and highway in the distribution of automobiles, of commodities shipped via the various forms of piggyback and containerization, and of liquid and dry bulk commodities. In each case, the advances have been in tune with our "short-order" economy, which combines these modes without intermediate storage operations (i. e., the transfer is direct). However, it appears necessary to develop a widespread consensus concerning the most advantageous intermodal systems before these systems will be widely adopted. Common systems seem necessary to resolve the physical interface problems remaining between the modes, and even between the rail-highway services of many individual railroads. This is especially true of containers for package shipments which will dominate the intermodal field just as plain boxcars and van-trailers dominate the rail and highway fields now. The public interest requires city planning support for rail-highway transfer terminals like the Port of New York Authority's water-highway-rail container transfer facilities prepared for private carrier use. Good planning would ease the problems railroads frequently encounter when a suburban community objects to the establishment of a transfer terminal in its area. Even though the inhabitants acknowledge the benefits of combining economic rail haul with the flexibility of truck delivery, they recognize that this requires that trucks with loads of packages, automobiles, or bulk freight fan out from a centralized terminal over their local streets. As more and more freight is handled in this way, the importance of new terminal thinking on a broad scope becomes clearly evident in order to avoid the objectionable hodge-podge of inefficient terminals and highway congestion. The challenge is to obtain agreement on the best rail-highway systems and to design efficient rail-highway terminals.

THE LOGISTICS CLIMATE IN OUR ECONOMY

Any discussion of container piggyback should recognize that there is a new climate in our economy. Today managements are shedding the same kind of attention and techniques that have been shed in the past on finance, production, and sale on an area that we might call "physical distribution" or "business logistics." This commercial interest is based on recognition that business logistics serves as a basic footing of profit and return on investment. Further, there is recognition of the need for the systems approach to integrate the wide number of independent but interrelated functions. Managements also recognize that business logistics is a severe area of marketing competition wherein they must strive to achieve their optimum service-cost compromise.

In considering the optimum use of logistics resources one finds that research is needed to evaluate the continuing flood of new technological concepts in terms of their economics and practicalities and their commercial relationships. Only later should

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one engage in the final phase of hardware design and evaluation. All too often transportation has jumped with major investment into production models before they had been fully evaluated. For example, while some practical progress was made through the use of concepts like trailer piggyback and the military Conex box, economic research would have shown that superior concepts were available. It is important that each mode play its most economic part both wherever it can handle transportation as a one-mode move, and where it relates to other modes in intermodal transport. Recent presentations by Department of Commerce officials indicate that the Federal Government intends to assume considerable initiative in sponsoring through-movement logistics with economic combinations of services of various modes and carriers.

Highway Carriers Reducing Costs

Any discussion of the economic climate must include comments on the progress being made by highway carriers to improve their costs and service. They are pushing for larger loads and they are being assisted in their efforts by public agencies sponsoring improved highways and higher vehicle size and weight limits. The truckers are pushing the use of unit loads, internal containers, and sound pricing to resolve their interface problems with shippers. If the railroads are to maximize their market penetration, profits, and return on investment, they must similarly improve their costs and provide the services which are required by the low-inventory, short-order, through-logistics economy.

SYSTEMS ANALYSIS REQUIRED FOR EVALUATION OF CONCEPTS

While recognizing that the terminal is the "nut" of the transportation business, it is also important to recognize that this nut must be cracked in order to achieve a high level of customer service and carrier profits. To evaluate intermodal transfer terminal concepts we need to use systems analysis for the analysis of alternative logistics patterns and look at both the economics and practicalities of the total overall service-cost relationship. The systems approach is necessary because a variation of solution depends on the characteristics of various commodities and the relative importance of primary rail line haul, secondary highway line haul, terminal handling costs, and customer costs. For example, the handling of package freight is very high. Therefore, it appears a good bargain to change from transporting package freight in box cars and requiring piece-handling into local delivery trucks to the use of demountable bodies involving a slightly higher primary rail line haul cost and a slightly higher secondary highway cost. The result is a net savings in the combination of rail and highway through the transfer of a full container of packages rather than the individual packages.

On the other hand, the reverse was true with automobiles. When the railroads first began to return the automobile traffic from the highway, they used a container for the transfer of a load of automobiles onto the rail car at the origin, and off of the rail car at the destination. However, the piece handling of automobiles is relatively inexpensive. Therefore, it is more economic to run up the origin terminal costs a little bit as we piece-handle automobiles into a high-capacity rail car and to run up the destination terminal costs somewhat as we piece-handle the automobiles out of the rail car and into the most efficient trailer for the states in which delivery is to be made, in order to get much greater savings in the primary rail line haul and the secondary highway line haul.

In the handling of liquid and dry bulk, it is generally more economic to transfer the commodities than a container of the commodity. Recently pressure hopper cars have been developed to utilize differential pneumatic pressure in the transfer between rail and highway of dry bulk solids such as cement, grain, feed, sugar, and phosphates.

INTERNAL CONTAINERS AND UNIT LOADS

Internal containers for small shipments and unit loads of various kinds are advantageous in areas of pick-up and delivery, dock handling, intermodal transfer, clerical control, damage reduction (as well as loss reduction), and equipment utilization.

Further use of the unit load is being made to eliminate a portion of break-bulk handling by shippers who build into the original unit load the proportional mix of different commodity items required by the average customer.

Forwarders, the Railway Express Agency, the Post Office, railroads, truckers, airlines, and ocean carriers make use of internal containers to consolidate shipments on receipt at their dock for efficient and rapid origin loading, intermediate breakbulk, and destination unloading of the line-haul vehicle with its high investment. Increasingly, internal containers are being moved directly from the shipper to the consignee wherein various types of inexpensive expandable, collapsible, and pneumatic floatation internal containers can be loaded into the line-haul units without important loss of cube, additions in weight, or additional expense.

ANALYSIS OF VAN CONTAINER ECONOMICS

The advantages in use of van type external containers have been well documented and widely accepted. They have run the gamut of improved pick-up and delivery involving reduced dock investment and handling costs for shippers, carriers, and consignees, and the advantages of combining multiple units for local pick-up and delivery and short highway hauls. It is important that truck-type dock facilities and the railroad container transfer or piggyback yards should be located adjacent to one another and as close to the economic center of pick-up and delivery of the terminal area as possible. These containers also offer the well-known advantages of reduction in loss and damage, and improvement in packaging, environmental control, and storage. This report, however, will also highlight some major but less well-known advantages in reduction of line-haul costs, both for primary rail line-haul and for secondary highway haul involving short distances and low density transportation areas.

Advantages Already Proved

While this concept of rail-highway transportation with truck-style docks and warehouses can be utilized with piggyback trailers as the line-haul container, it should be pointed out that containers offer considerable advantage over trailer piggyback in enabling shippers to gradually move from their present carload concepts and facilities to rail-highway concepts. For example, the New York Central's flexi-van concept has been modified so that the containers have side doors and can be loaded inside a traditional Post Office baggage car facility while the containers sit on the rail cars. On the New York Central, the Post Office department is loading flexi-vans in such eastern baggage car terminals as New York and Boston, while at Chicago the container is taken off of the car and moved directly to the outlying Post Office facility. This results in a considerable increase in speed and reduction in cost over the former method of handling the mail out of a baggage car, across a dock, and then into a local delivery truck for the same local transportation.

Future Container Transfer Concepts

A concept which bears merit is the terminal-handling piece of equipment called a straddle or van carrier. These units can pick up a van, lift it high enough to leapfrog over other vans still remaining on adjacent rail cars, and carry it at speeds of 20 mph or so to a location where it can be placed for unloading at a truck-style dock without the container ever requiring its own chassis or wheels. In a similar manner the container could be placed on a chassis or bogey for handling over the highway within the terminal city or surrounding area. This concept is not a figment of our imagination but a workable concept which has been in operation at various port facilities for more than five years. Economic analysis shows it to be the most efficient method of taking a container from a train to a dock or highway chassis, and it is far superior to breaking or making trains with switch engines or various forms of piggyback loading and unloading. It is possible to envision future terminals as a complex of truck-style docks adjacent to the container transfer yards.

A mobile gantry crane of the kind which is currently mounted on either rubber tires or steel rail wheels has its greatest applicability where trailers must be lifted sideways off of a rail car or for use at intermediate terminals. Here the train is pulled off of the main line into a terminal where inbound containers are taken off, outbound containers are placed on, in a matter of five minutes to half an hour, and the train progresses en route without recourse to a switch engine. This concept is obviously far superior to the present container and piggyback concepts which set out inbound loaded cars at intermediate spots for subsequent unloading, and which pick up outbound cars that have already been loaded. An ideal concept would be to sell the seat over twice, as they discuss the matter in the passenger business. However, minor work remains to be done in improving the cost and reliability of overhead transfer equipment.

Shuttle Trains for Quality Service, Equipment Utilization, Low Cost

Achieving improved service and equipment turnaround through use of all-container or solid piggyback trains has progressed quite well. These were initiated in 1960 by the New York Central with its super-van trains, which are achieving utilization of approximately 14 revenue trailer loads per month with an average haul of over 800 miles per car. Analysis has indicated the pattern in which this shuttle train concept will probably evolve. Near the trip origin or destination it is more economical to pay the cost of breaking up the train from its full length; whereas for intermediate stops it is cheaper to leave the train intact. In this way, operating between a limited number of terminals, the rails can achieve costs considerably below those of the highway for similar line haul operations. This then enables them to achieve the best balance of economic rail for the line haul and flexible truck for the dock handling and pick-up and delivery operations.

Economics of Blending High and Low Density Shipments

The economics in the above analyses were based on present container costs, which are lower than comparable piggyback costs. Whereas the letters TOFC were used to describe piggyback and the letters COFC were used to describe container-on-frame-car, the letters SCOFC denote the newer concept of stacking-container-on-frame-car. This concept employs containers to bring to the railroads the full advantages of the optimum blending of weight and cube to utilize the full capacity of advanced rail car concepts. This blending of high-density and low-density freight to take advantage of the full weight and cube capacity of vehicles has been prevalent for many years in both the deep water and the highway industries.

Rather than carry a maximum cube load of low-density items and a maximum weight load of high-density items from town A to town B, a trucker will endeavor to carry a mixed load of both commodities in each trailer. Under the former circumstance he might have in one trailer a load of 15,000 lb and 2,400 cu ft and in the second trailer a load of 48,000 lb and 1,000 cu ft. With a blend of the two commodities it is possible to achieve a load of 35,000 lb and 2,400 cu ft in each trailer. Thus the capacity utilization of the two trailers has been raised from 3,400 cu ft to 4,800 cu ft and from 63,000 lb to 70,000 lb merely by mixing the light and dense freight.

Maximizing Utilization of Rail Car Cube and Weight Capacity

The TOFC or COFC method wastes a considerable amount of cube either below the trailer or above the container. The value of this cube to the railroads was exemplified in the transportation of automobiles where attempts were made to use fully the cube that lay between the top of the rail chassis and beneath the overhead clearance. This demonstration of cube value indicates that, other things being equal, the railroad with the better clearances may ultimately be the lost cost producer.

The SCOFC concept of stacking containers one on top of another utilizes the full cubic capacity available. The center of gravity will generally be lower than with piggyback or some of the high cube hopper cars. Shorter containers may also be used in the lower tier for the handling of dense commodities such as canned goods or drums of chemicals.

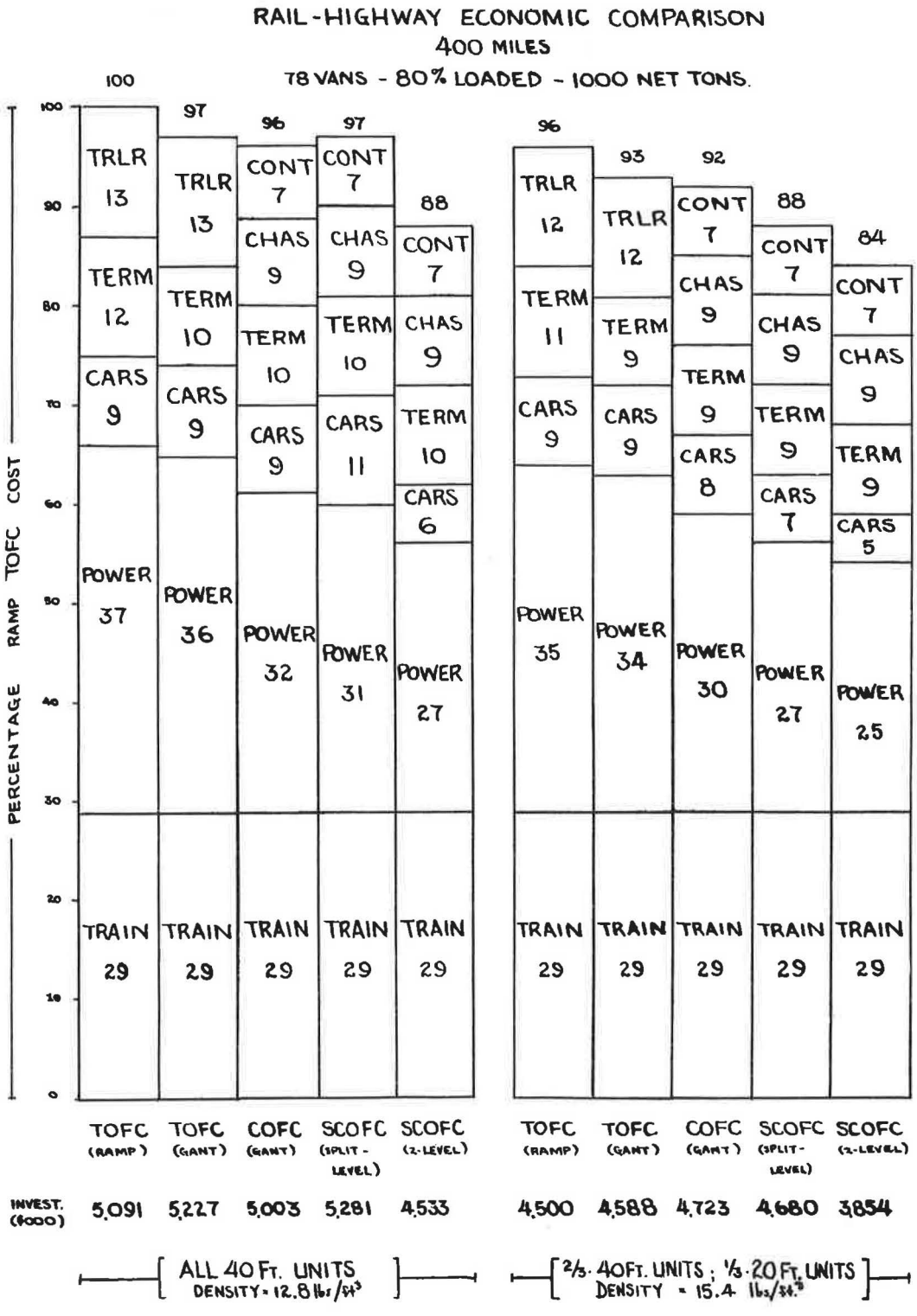
RAIL-HIGHWAY ECONOMIC COMPARISON
400 MILES
78 VANS - 80% LOADED - 1000 NET TONS.
PERCENTAGE RAMP TOFC COST
100
97
96
97
88
96
93
92
88
84
TRLR 13
TERM 12
CARS 9
POWER 37
TRAIN 29
TRLR 13
TERM 10
CARS 9
POWER 36
TRAIN 29
CONT 7
CHAS 9
TERM 10
CARS 9
POWER 32
TRAIN 29
CONT 7
CHAS 9
TERM 10
CARS 11
POWER 31
TRAIN 29
CONT 7
CHAS 9
TERM 10
CARS 6
POWER 27
TRAIN 29
TRLR 12
TERM 11
CARS 9
POWER 35
TRAIN 29
TRLR 12
TERM 9
CARS 9
POWER 34
TRAIN 29
CONT 7
CHAS 9
TERM 9
CARS 8
POWER 30
TRAIN 29
CONT 7
CHAS 9
TERM 9
CARS 7
POWER 27
TRAIN 29
CONT 7
CHAS 9
TERM 9
CARS 5
POWER 25
TRAIN 29
TOFC (RAMP)
TOFC (GANT)
COFC (GANT)
SCOFC (SPLIT-LEVEL)
SCOFC (2-LEVEL)
TOFC (RAMP)
TOFC (GANT)
COFC (GANT)
SCOFC (SPLIT-LEVEL)
SCOFC (2-LEVEL)
INVEST. ($000)
5,091
5,227
5,003
5,281
4,533
4,500
4,588
4,723
4,680
3,854
ALL 40 FT. UNITS
DENSITY = 12.8 lbs/ft³
2/3 · 40 FT. UNITS ; 1/3 · 20 FT. UNITS
DENSITY = 15.4 lbs/ft³

Figure 1.

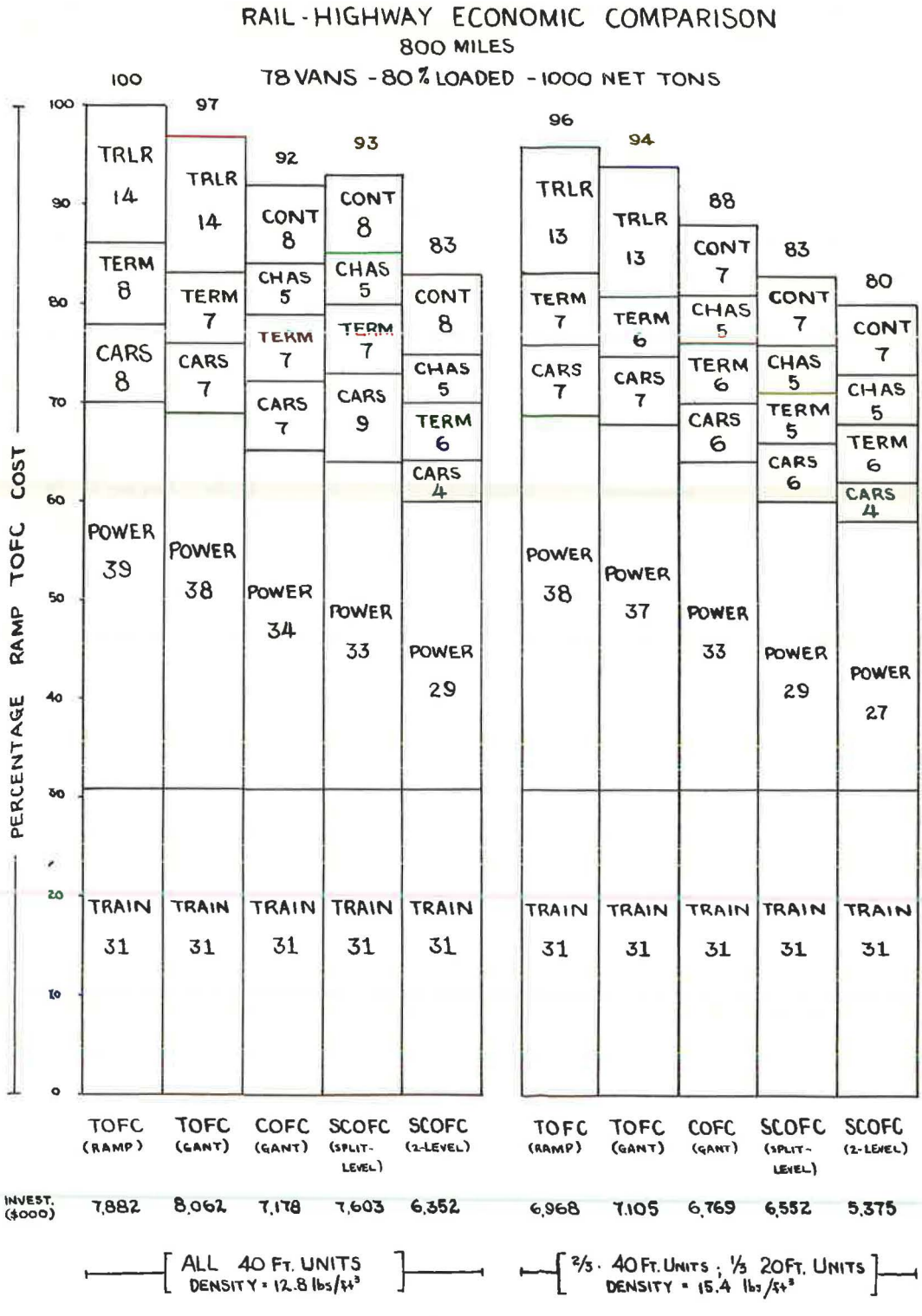
RAIL-HIGHWAY ECONOMIC COMPARISON
800 MILES
78 VANS - 80% LOADED - 1000 NET TONS
PERCENTAGE RAMP TOFC COST
100
97
92
93
83
96
94
88
83
80
TRLR 14
TERM 8
CARS 8
POWER 39
TRAIN 31
TRLR 14
TERM 7
CARS 7
POWER 38
TRAIN 31
CONT 8
CHAS 5
TERM 7
CARS 7
POWER 34
TRAIN 31
CONT 8
CHAS 5
TERM 7
CARS 9
POWER 33
TRAIN 31
CONT 8
CHAS 5
TERM 6
CARS 4
POWER 29
TRAIN 31
TRLR 13
TERM 7
CARS 7
POWER 38
TRAIN 31
TRLR 13
TERM 6
CARS 7
POWER 37
TRAIN 31
CONT 7
CHAS 5
TERM 6
CARS 6
POWER 33
TRAIN 31
CONT 7
CHAS 5
TERM 5
CARS 6
POWER 29
TRAIN 31
CONT 7
CHAS 5
TERM 6
CARS 4
POWER 27
TRAIN 31
TOFC (RAMP)
TOFC (GANT)
COFC (GANT)
SCOFC (SPLIT-LEVEL)
SCOFC (2-LEVEL)
TOFC (RAMP)
TOFC (GANT)
COFC (GANT)
SCOFC (SPLIT-LEVEL)
SCOFC (2-LEVEL)
INVEST. ($000)
7,882
8,062
7,178
7,603
6,352
6,968
7,105
6,769
6,552
5,375
ALL 40 FT. UNITS
DENSITY = 12.8 lbs/ft³
2/3 · 40 FT. UNITS ; 1/3 20 FT. UNITS
DENSITY = 15.4 lbs/ft³

Figure 2.

Research shows that many commodities run in a density of 48 pcf or higher and can fill a 20-ft van container to the maximum weight capacity allowed by highway law for any particular trailer unit. In fact, 20-ft containers with higher weights would probably have to be placed on stretch frame trailers to meet the bridge laws. Prototype stretch frame trailers have been designed which will accept maximum highway weight loads in any combination of single 20, 24, 28, or 30-ft containers or two 20-ft containers.

Analysis of Rail-Highway Container Economics

The basic investment and cost factors which were highlighted in the economic analysis of each integrated rail-highway container system and their effects on the overall systems are the following:

1. Power—Less power investment and cost required with lighter and/or fewer cars and containers used under COFC and SCOFC. Power requirements are also reduced because of lower center of gravity needing fewer slow-down-speed-ups and because of lower wind resistance.
2. Containers and Undercarriages—Less container investment and cost under COFC and SCOFC because of savings in tax on containers, fewer undercarriages required on trips of two days or more. (The analysis considered an increase in undercarriages at 400 mi and a 3:5 ratio at 800 mi.) As the most numerous item in the system, containers should be designed with as little investment and cost as possible.
3. Rail Cars—The manner of terminal loading and unloading greatly affects the investment, weight, and cost of the cars. Cars for overhead loading of containers can be of a simple frame design without end plates, side sills, or stanchions. Flexible use of 20-ft containers and SCOFC also allow fewer cars.
4. Terminals—Industrial engineering evaluations of the investment and cost in land, switches, track, paving, transfer equipment, and labor for each system have been included in the analysis. Concentrating investment for transfer capability in the overhead transfer equipment reduces the cost of this factor to an insignificant amount because of the low unit cost of high utilization, and because of savings in other factors. In fact, the apparent high investment of gantry cranes actually results in minimum cost even for relatively low volume terminals.
5. Flexibility—While not accounted for in the analysis, the advantage of selective side transfer is important to improvement in service elapsed time and reduction in switching. Similarly, fast side transfer will allow increased utilization of car equipment (and the servicing of more points) as the "seat" is sold twice at intermediate stops. Finally, containers with a floor at dock level when loaded on the car facilitate the change from box and baggage cars to rail-highway equipment.

Advantages of using the COFC and SCOFC concepts are that railroads can achieve fuller use of their cube and weight capacity for the line haul, and the line-haul costs which were already considerably below those of highway have had their superiority increased considerably. Analysis shows the savings that can be achieved in both investment and variable costs by moving toward the COFC and SCOFC concepts from traditional piggyback concepts. The figures also show the advantages to be gained by loading the dense commodities into smaller containers. Car manufacturers must considerably improve the ride characteristics of their cars. Perhaps similar requirements for passenger trains will influence the design of improved trucks with improved tracking and thus lateral and vertical shock characteristics, maybe through air suspension.

Highway Trains Serving Off-Line Centers

The use of 20-ft containers in the secondary highway line haul has its advantages. In the servicing of a satellite area approximately an hour away from a rail container transfer yard it would be desirable to have the smaller units hauled to the destination city as economically as possible. Where the 20-footer represents either the maximum weight load allowable on the highway, or a day's work for a pick-up and delivery driver, it is an unnecessarily high cost for the driver to transport only one 20-footer behind him from the transfer terminal location to the destination city. Instead these units can be

combined through the joining of trailers, the use of double or triple bottoms, or finally, the use of individually powered trains as with Wolf Wagons. In the latter concept, the individually powered unit concept is being progressed to where the body is a demountable 20-ft container and the chassis so designed that a maximum load approaching 40,000 lb can be carried. In addition, the truck can nose up to the dock and the driver has easy access to the freight through the front of the container with resulting savings in both elapsed time and labor content. With side doors, access can be had to all the freight so that the extra cost of route-stop-sequence loading can be eliminated.

Containers Facilitate Business Logistics

From the preceding, one can see how containers fit into the new physical distribution concepts which are evolving on the basis of systems analysis and development using the latest technology for the communication of inbound orders, order and data processing, order picking and materials handling, and direct movement transportation.

Attention should be called to the manner in which the planning already progressed by the Buffalo city fathers for their Thruway Industrial Park can be utilized to develop an ideal Buffalo Distribution Center. Here two major railways could locate competing container transfer yards and access could be provided from these yards to manufacturing and distribution facilities with van carriers if the streets were planned sufficiently wide and without low overhanging wires. Access is available to the main superhighway network for ready movement to other locations of plants and distribution facilities in the surrounding geographic area.