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Urban Goods Movement — The Key To Improved Transportation Productivity

*by John H. Marino**

INTRODUCTION

AMERICA's transportation industry has made tremendous strides in line-haul transportation productivity. The new generation of jet freighters has helped stabilize the cost of air cargo; highway freight carriers, operating over the nearly completed Interstate Highway System (frequently with high-capacity tandem trailers) have significantly increased motor carrier transportation productivity. Railroad unit-trains, moving large volumes between fixed terminals on predetermined schedules, have helped the railroads retain traditional traffic, and capture new tonnage. Inland waterway operators, using high-powered towboats and large integrated tows, have maintained historically low rate levels, and increased their market share.

Unfortunately, however, many of the gains made in line-haul transportation productivity have been offset by increased delay and congestion in urban areas. The interface between transport modes, and between transportation companies and their customers, has become one of the critical problems facing the transportation industry today. Unless measures are developed to streamline and facilitate the interchange of goods within our metropolitan areas, the benefits anticipated from the tremendous capital investments made in these line-haul systems may never be fully achieved.

The subject of local movement of goods by truck within metropolitan areas is receiving increased attention, however, primarily due to three factors:

1. The need to more effectively integrate goods movement considerations in the development of comprehensive regional transportation plans (as required by the Federal Highway Act of 1962).

2. The concern expressed by the business community and government agencies over the rising costs of such local goods movement operations, and the impact of these costs on the economic base.

3. The impact which excessive vehicle travel has on environmental quality and limited fuel resources.

BACKGROUND OF URBAN GOODS TRANSPORTATION

A Task Force of the Institute of Traffic Engineers (of which the writer is a member), reviewing progress made by various state and local transportation planning agencies, found little evidence of comprehensive, ongoing programs involving the movement of goods in urban areas.

Associate, A. T. Kearney, Inc.

Research by the Tri-State Planning Commission (New York Metropolitan Area), has shown that 72% of freight tonnage within the region was carried by truck, and that truck transport accounted for 97% of total internal distribution costs.

Clearly, an understanding of the use of truck transportation in the urban area is essential for effective regional planning.

(a) Comprehensive Planning

Comprehensive regional transportation planning efforts until recently have been focused on the movement of people. This is slowly changing as the relationship of land use and freight transportation is more thoroughly understood. However, this process to date has not been much more than acknowledgement that a problem exists.

Urban goods movement affects other aspects of the regional transportation plan. For example:

1. Goods movement is generally competitive with the movement of people. Trucks and automobiles share the same highway facilities during peak traffic periods.

2. Terminal facilities are land-intensive, often competing for the limited supply of land in metropolitan areas, which have other pressing needs, such as housing, recreation and industrial development.

3. The fragmented, uncoordinated nature of local goods movement activities complicates the development of sound, comprehensive, regional plans. This is due to the competitive nature of for-hire transportation companies, the nature of regulatory and administrative controls exercised by federal, state and a multiplicity of local government agencies, and the diverse needs of various commercial and industrial enterprises who require transportation services.

Contributing to the lack of effective goods transportation planning has been a severely limited data base. Planners have not been provided detailed, accurate statistics on freight origin and destination, methods of transportation used, and characteristics of the flows such as costs, service requirements, and commodities. Consequently, truck transportation planning has generally been limited to the quantification of the impact of trucks on the general highway stream, and the provision for trucks in highway design.

(b) Truck Transportation

Truck traffic may account for between 5% and 20% of all vehicles in the urban traffic stream. Traffic planners will frequently assign trucks an "equivalency" factor of two or more automobiles per truck in determining highway capacity. Consequently, as much as 40% or more of the traffic-moving capability of certain urban arterial highways and freeways may be utilized by trucks. To effectively plan future transportation facilities, it is important to understand what purposes trucks are used for and the relationship between truck traffic and land use patterns.

The 1967 Census of Transportation found that the majority of trucks were operated by private firms, many of them for purposes other than for the movement of goods. This is illustrated by the fact that more than one-third (33.6%) of all trucks were used for personal transportation. Table 1 indicates major truck usage.

It is clear that for-hire trucks are utilized more intensively than other types of trucks; they account for only 4.4% of all trucks, but 13.7% of all truck-miles. The Census of Transportation also found that 59% of all trucks operated only within the local, immediate area.

Truck transportation is an essential ingredient of a sound economic base. Virtually all goods move by truck within the urban area for part of the total trip. However, the great variety of truck traffic flows complicates the planning for the required street and highway facilities. The following types of flows illustrate this variety.

— Highway freight may pass through a city en route to its destination.

— Local truck shipments originate and terminate within the city.

— Air cargo moves to and from airport terminals by truck.

— All U.S. Mail, small parcels and express shipments move by truck to and from consolidation facilities.

— Intermodal shipments usually move between terminals and customers

PRINCIPAL USES OF TRUCKS

Major Use	Percent of Trucks	Percent of Truck Miles
Personal Transportation	33.6%	24.9
Agriculture	24.1	15.9
Construction	9.3	9.6
Manufacturing	2.4	4.0
Wholesale and Retail Trade	12.2	17.0
Utilities and Services	8.0	7.5
For-Hire	4.4	13.7
All Other Uses	6.0	7.4
Total	100.0%	100.0

Source: *Truck Inventory and Use Survey*, 1967 Census of Transportation, Bureau of the Census, U.S. Department of Commerce, Washington, D.C., 1970.

TABLE 1

by truck. This would include piggyback shipments and containerized freight, as well as bulk commodities moving to and from port facilities.

— A portion of conventional rail freight shipments moves over the streets and highways. This would include freight forwarder traffic, shipments to and from rail team tracks, and bulk commodities distributed by truck from special rail terminals.

— Many products transported by pipeline are distributed by truck to final user. Examples of this would be jet fuel, gasoline, chemicals and fertilizers.

Any policy regarding truck transportation in the metropolitan area must recognize the diverse uses made of trucks, and the variety of types of equipment to be found. Clearly, such a policy must recognize the differing impacts such policies may have on private trucks as opposed to those operated for-hire.

(c) Increasing Costs

The result of planning efforts for truck transportation to date has been the evolution of a costly system of local goods movement, the inefficiency of which must ultimately be passed on to the consumer in the form of higher prices.

Transportation represents a significant, and increasing, percentage of the delivered cost of goods. Although on the average, transportation costs are approximately 20% of total delivered costs for manufactured goods, it can be 50% or more for certain low-value commodities (such as coal or gravel).

The cost of local goods movement has been increasing at a faster rate than has the volume of longer-haul intercity freight movement. This is due in part to the increasing concentration of economic activity in urban areas with its resultant congestion; increasing consumption of lighter-density, high-value commodities; as well as the increased emphasis on improved transportation service (i.e,., faster, more frequent delivery of smaller shipments). During the period from 1958 to 1972, local trucking costs increased at an annual rate of 9.1%. Intercity truck ton-miles increased at a rate of approximately 1.5% per year.

Estimates developed by the Transportation Association of America[1] show that in 1971 expenditures for intercity truck transportation totalled $38.5 billion and that expenditures for local truck transportation totalled $41.1 billion. Exhibit 1 shows that local trucking costs have exceeded those of intercity truck transportation for all but one year between 1958 and 1971.[2]

Several proposals have been made in recent years by various governmental agencies to improve the efficiency of local truck transportation. These proposals include the following:

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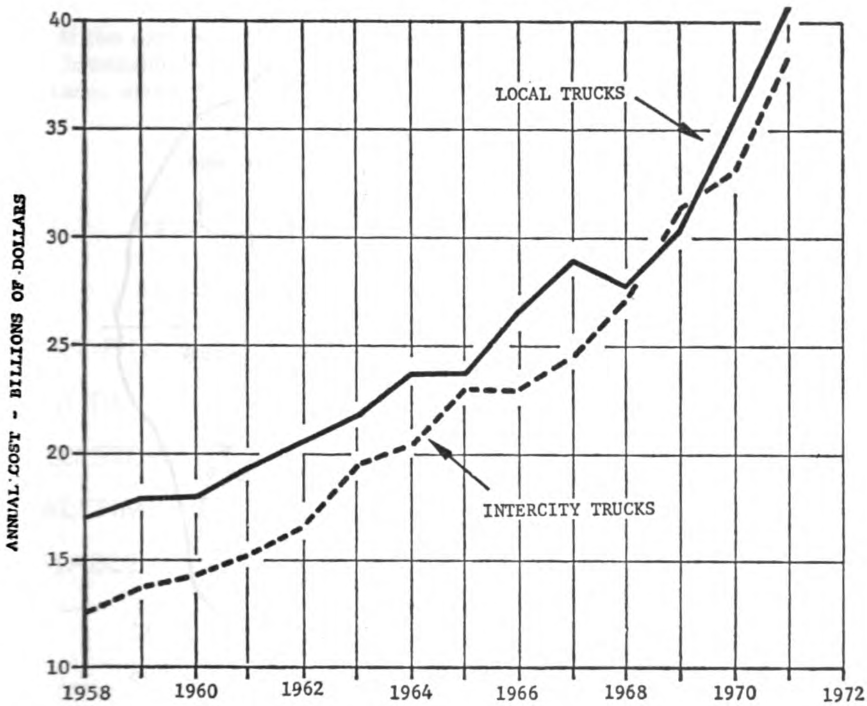
1 **Transportation Facts and Trends**, Transportation Association of America, Washington, D.C. April, 1972, Ninth Edition.

2 Since the TAA estimate of intercity truck transportation costs include costs of local pickup and delivery, duplicating somewhat the estimate of local trucking costs, it is likely that local trucking costs exceed intercity by a large margin.

COMPARATIVE COSTS OF INTERCITY AND LOCAL TRUCK TRANSPORTATION



Source: *Transportation Association of America.*

EXHIBIT 1

- Terminal consolidation
- Shipment consolidation
- Restrictive traffic control ordinances
- Improved loading and unloading operations

In order to illustrate the relative impacts of these proposals, a hypothetical case study city was used to evaluate the overall transportation economics of each of these proposed alternatives.

EVALUATION OF ALTERNATIVE PROPOSALS

A hypothetical case study city, representative of a typical medium-sized metropolitan area was used to evaluate the four alternatives.

This city, shown in Exhibit 2, consists of four truck terminals, each serving a sector of the city, with ten delivery routes each. It is assumed that

CASE STUDY CITY

HYPOTHETICAL TERMINAL LOCATIONS

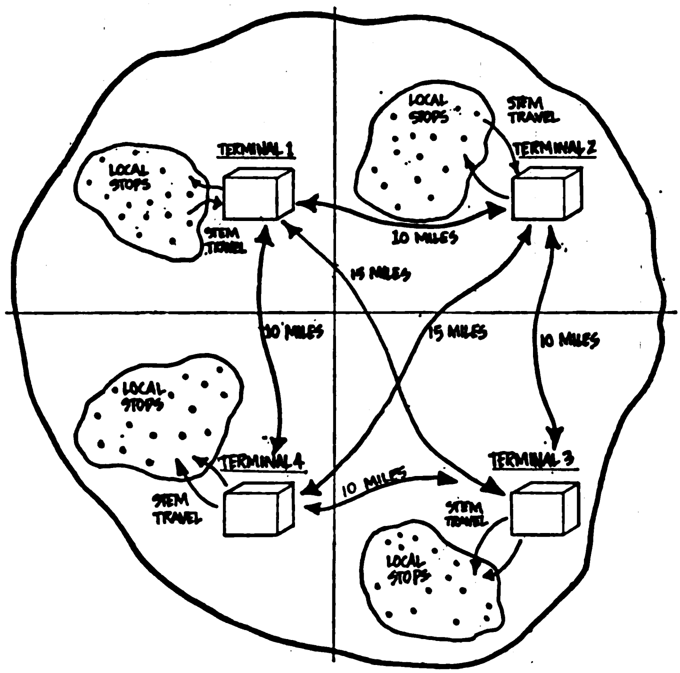


EXHIBIT 2

each route consists of a total of 15 stops per day, both pickup and delivery, with an average shipment size of 1,000 pounds (20 pieces of 50 pounds each). Line-haul service is provided by three over-the-road units daily.

Operating costs for this system were estimated, using route engineering techniques and predetermined work standards. Calculation of delivery times is based on the following principal elements:

— Fixed start and finish time (equipment servicing, paper work, dispatching, etc.).

— Stem travel (travel time to the first stop, and from the last stop to the terminal).

— Meal times (may be paid or unpaid).

— Fixed stop times (time to maneuver into dock, park, open doors, check bills, etc.).

— Variable stop time (travel time between stops, and shipment handling time).

Application of representative standards to one of the case study routes is shown in Table 2. This calculation does not include allowances for unusual delays, such as abnormal congestion, accidents or mechanical breakdowns.

If the route was operated 250 days per year, annual cost would be $272,000. Interestingly, the truck on this particular route is in motion only *18%* of the time, about 1.8 hours per day.

APPLICATION OF STANDARDS TO A REPRESENTATIVE LOCAL DELIVERY ROUTE

Activity Element	Minutes per Day
START-FINISH TIME	30
STEM TRAVEL (10 miles at 30 miles per hour)	20
FIXED STOP TIME (5 minutes per stop × 15 stops)	75
MEAL TIME	30
VARIABLE STOP TIME	
— Travel (2 miles per stop at 20 miles per hour × 15)	90
— Shipment handling (3,000 pounds per hour or 20 minutes × 15 shipments)	300
Subtotal	545
NORMAL DELAYS (5%)	27
Total	572

Assuming a 10-hour workday, this particular driver performs at 95.3% of standard (572 ÷ 600 minutes). Cost per route can be calculated, as shown below:

Cost Basis	Units	Cost per Unit	Total Daily Cost
Hours	10	$10.00	$100.00
Miles	40	0.22	8.80
Total			$108.80

TABLE 2

Other operating costs for the terminal were also developed. These are summarized below:

Terminal Operating Cost Calculation

Daily throughput – 150,000 pounds
Dock production labor –
150,000 pounds ÷ 3,000 pounds per man-hour =
5 men on a 10-hour shift

Allowances for weekend and vacation relief –
2 men

Labor cost	7 men	$ 84,000
	1 clerk	8,000
	1 supervisor	15,000
	Subtotal	$107,000
	Fringe Benefits	22,500
	Total	$129,500
Facility costs		
	10-door cross-dock terminal rent, maintenance, other operating expenses, taxes, utilities	48,000
Interline trips		
	1 trip daily to 3 terminals	12,000
	Grand Total	$109,500

The annual cost for the four-terminal case study city amounts to $1,-846,000, as shown in the following:

Delivery routes	1,088,00
Interline trips	48,000
Terminal operating costs	710,000
Total System Cost	$1,846,000

(a) Impact of Terminal Consolidation

Much has been said about the potential impact of terminal consolidation. This would reduce the number of individual facilities, and hopefully concentrate activity in areas zoned for these activities. However, highly centralized, concentrated terminal operations result in significant increases in stem travel costs. In the example, 40 city trucks would incur additional travel time, while only 12 line-haul vehicles might save time traveling to and from a central terminal. If over-the-road factors could be increased as a result of terminal consolidation, certain reductions in line-haul cost might be realized.

Exhibit 3 portrays the pattern of truck terminal locations in the New York City area, for major intercity common carriers of general freight. A

MAJOR MOTOR CARRIER TERMINALS—NEW YORK CITY AREA

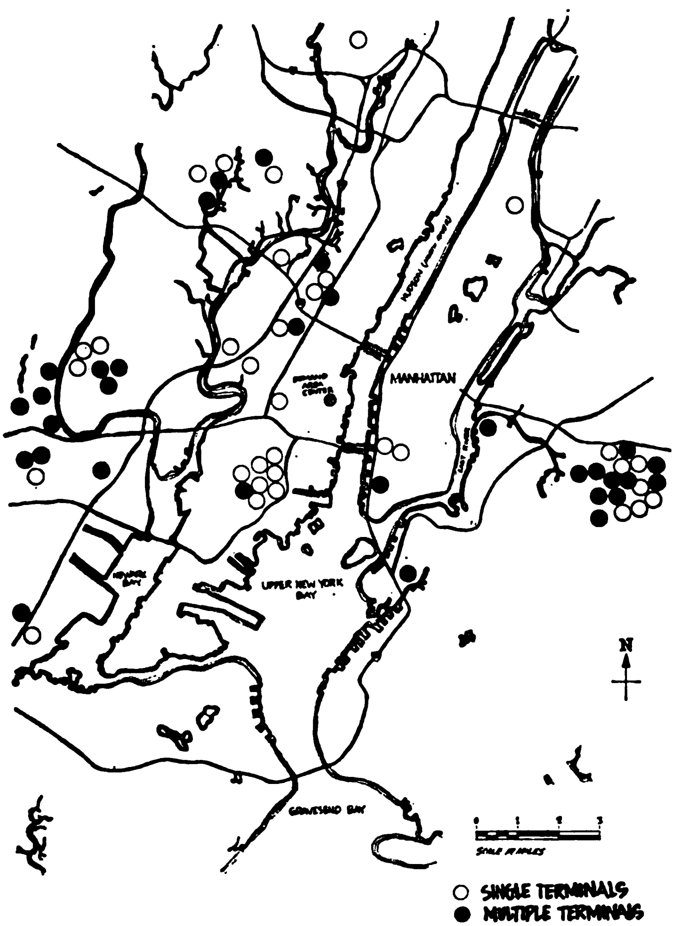


EXHIBIT 3

total of 42 carriers operate 58 facilities, of which 30 are multiple facilities. Quite frequently, a company may operate a terminal in New Jersey, and one in the Borough of Queens. Each facility generally serves its own market area, with only occasional overlapping of pick-up and delivery trips.

The dispersion of terminals from the approximate demand center (which lies between the Holland and Lincoln Tunnels in New Jersey), is quite apparent. Many carriers are experimenting with multiple "satellite" terminals in the larger metropolitan areas.

The cost impact of consolidating four facilities at one central location in the case study city can be estimated. With a terminal located in the approximate center of the market, additional stem travel for each delivery truck would be about 15 miles. Added costs would amount to about $83,000 per year. As there would no longer be a need for interline runs, the result is a net increase in costs of $35,000 per year. Savings in linehaul costs would probably not be significant.

Dock productivity would probably decline with the new terminal. Instead of a smaller 60-foot × 100-foot cross-dock operation, the new facility might have a dock 300 feet × 70 feet with longer travel distances. Production rates would consequently drop, from 3,000 pounds per man-hour to about 2,500 pounds per man-hour.

Certain economies of scale would be realized in supervision and clerical costs, as well as facility ownership and maintenance. Consequently, terminal operating and maintenance costs would amount to about $653,200 per year. Total system costs would be $1,777,000, or a reduction in cost from the base case of about 4%.

(b) Impact of Consolidated Shipments

If shippers could be persuaded to reduce the number of individual shipments, either by using fewer carriers or shipping fewer small orders, cost could also be reduced.

Exhibit 4 illustrates the total distribution cost of shipping various size customer orders. The example represents various consumer and industrial products produced at a central plant, and distributed within a market area 700 miles away. The two cost curves reflect the alternatives of delivery direct to customers, or from a local warehouse, and include inbound and outbound freight, order processing costs, truck loading and unloading, warehouse handling and inventory carrying costs. Clearly, in this example, orders larger than 1,000 pounds could be direct-delivered more economically than through a local warehouse, with subsequent rehandling and local delivery. Regardless of the method of delivery, however, shipment consolidation offers opportunity for cost reduction.

Returning to our case study city suppose customers could be persuaded to ship 2,000-pound orders every other day, versus 1,000 pounds daily. Each truck would be able to make 10 stops per day rather than 15 stops, in the base case. With fewer customers to serve daily, only 7 trucks would be needed per terminal (rather than 10 as in the base case). Delivery costs would be reduced 28% below those of the base case.

COMPARISON OF DIRECT DELIVERY
VERSUS LOCAL WAREHOUSE DELIVERY

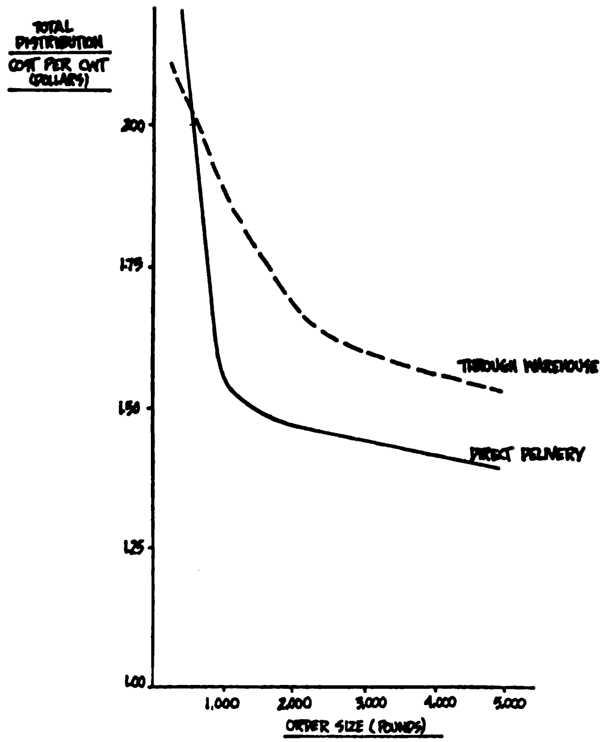


EXHIBIT 4

Larger shipments would also result in more efficient terminal handling. Instead of dock productivity of 3,000 pounds per man-hour, a rate of 4,000 pounds might be achieved, with a reduction in terminal labor costs.

The overall impact on total system costs of consolidated shipments should reflect the added costs of carrying inventory by the customer. If the typical customer now carries an average inventory of 500 pounds daily (shipment size of 1,000 pounds), and increases this to 1,000 pounds (shipment size of 2,000 pounds), inventory carrying costs will increase. Assuming a value of $1.00 per pound, and a cost of carrying inventory of 25% per year, this represents an increase of $125 per year, or $18,750 for all 150 customers served by each terminal.

The overall net effect on total system costs through shipment consolidation is summarized below. Costs are reduced almost 17% below those of the existing system.

Delivery cost — 4 terminals	$ 780,000
Interline trips	48,000
Terminal operating costs — 4 terminals at $163,000	652,000
Subtotal	$1,460,000
Customer Inventory Carrying Costs — 4 terminals at $18,750	75,000
Total System Cost	$1,535,000

Interestingly enough, this concept results in lower *total system costs*, as long as product value remains less than $5 per pound. Thus, it is feasible for all but higher value commodities (i.e., electrical apparatus, jewelry, fashion goods, drugs, etc.).

(c) Impact of Reduced Travel Time

Proposals have been made that would result in faster truck travel, through measures such as exclusive truck lanes and truckways, as well as standard traffic engineering approaches that would affect the total traffic stream. As pointed out earlier, even at an efficient level of operation, a delivery truck is in motion only about 18% of the time. Probably, the greatest contribution that the measures would have would be the elimination of excessive delay time and congestion en route, through programs such as the Federal Highway Administration's TOPICS programs, (Traffic Operations Program to Increase Capacity and Safety). This program often includes additional lanes on congested highways, turn lanes, improved signaling and controls.

In our example, suppose stem travel speed was increased to 40 miles per hour, and in-zone speeds to 30 miles per hour. The overall effect per truck would be a reduction in travel time from 110 minutes per day to 75 minutes per day. This would allow more time for deliveries, (18 per day versus 15).

This would require only 8 trucks at each terminal. Total system costs would be $1,604,600 per year, or a reduction from the base system of 13.1%. Travel time as a percentage of total then becomes only 14.6%.

If these improvements were accomplished using after-hours pick-up and delivery, it would be necessary to incorporate the added costs to the individual businesses, due to overtime payments and shift differentials (as well as any premium payments to drivers). If each customer incurred an additional hour of overtime for shipping and receiving activities, costs would increase by the following amount:

600 customers × 1 hour per day × 250
days per year at $4.50 per hour = $675,000

In this case, total system costs would be $2,279,600 or an *increase* of 23.5%.

(d) Impact of Reduced Unloading Time

Unloading time can be reduced through improved facilities, such as off-street loading bays, truck-level docks, hydraulic lift-gates, dock levelers, unitized loading, and improved materials handling (forklifts, power conveyors, roller-bed trucks, etc.), as well as improved scheduling and control of shipments by customers.

If it is assumed that fixed stop time might be reduced (say from 5 minutes per stop to 3 minutes per stop), and variable shipment handling time reduced by half from 20 minutes per shipment to 10 minutes per shipment, the impact would be an increase in stops per day, from 15 to 27.

Under these conditions, only 5 trucks would be needed to serve all customers. Total system costs would be $1,369,000, or a reduction of 25.8% below the base condition.

Exhibit 5 illustrates one concept developed by A. T. Kearney to facilitate truck loading and unloading. The Carousel Truck utilizes a cage system for small shipments. Each cage, capable of holding up to 2,000 pounds of freight, is moved by a hydraulically activated chain drive system, providing random access to each shipment. Cages may be removed for handling within a terminal or plant or, used in the captive mode, with the driver loading and unloading each stage.

CONCLUSIONS

The relative impact of each of the four major proposed strategies is shown in Table 3. The *single* best strategy would be to reduce the cost of loading and unloading trucks. With a potential saving of $447,000 per year[3]

COMPARISON OF ALTERNATIVE URBAN GOODS TRANSPORTATION STRATEGIES

Alternative Strategy	Annual Cost	Percent Change from Base Condition
Base Condition	$1,846,000	—
Terminal Consolidation	1,777,200	— 3.8
Shipment Consolidation	1,535,000	—16.8
Reduced Travel Time—Daytime Delivery	1,605,600	—13.1
Night Deliveries	2,280,600	+23.5
Reduced Unloading Time	1,369,000	—25.8

TABLE 3

3 Potential savings by shippers and receivers, through improved loading/unloading practices are not included in this estimate.

THE CAROUSEL TRUCK

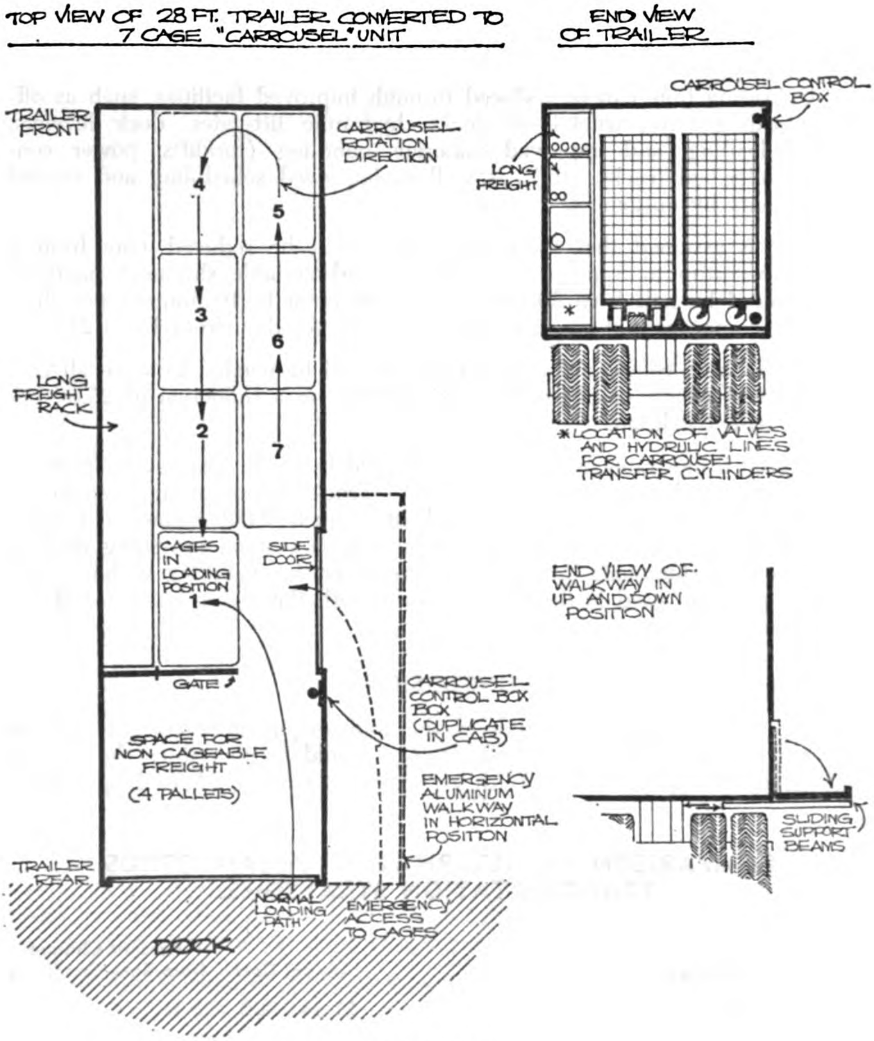


EXHIBIT 5

compared to the base condition, a major capital expenditure could be justified for both facilities and equipment. Assuming that these expenditures were amortized over a useful life of ten years, and that cost of capital is 8% per year, approximately $3.2 million could be spent today. This is the equivalent of $5,300 for each of the 600 customer facilities in the case study city.

Combinations of strategies might be adopted so that savings would be additive and perhaps justify additional expenditures. Clearly, a comprehensive total systems analysis for the specific city under consideration would be necessary to identify the optimal strategy for a given area.

Substantial benefits will accrue from such a strategy to both the users of transportation (through reduced costs), as well as other segments of society (through improved environmental conditions and fuel conservation for example). Under the strategy of reduced unloading time, for example, total trucks in the fleet are reduced by 50%, and truck-miles by 12.5%.

It is essential, however, to recognize the importance of considering *total systems costs*. In particular, planners must understand the underlying purposes for the movement of goods within the urban environment, and be aware of the differing impacts that alternative strategies have on various public interest groups. Thus, the best strategy is one that properly balances the interests of the motoring public, the operators of private trucks, for-hire operators, and the citizens who reside within the urban environment. A cost-benefit "trade-off" analysis is essential to determine the optimum transportation plan.

To ensure that this strategy is, in fact, attained, an action plan for both shippers and motor carriers could be developed. Typical elements of such a plan are shown in Table 4.

Public agencies should develop closer working relationships with both transportation users and carriers. Programs to foster the development of a local urban goods transportation strategy should be implemented. These might include:

— Measures to facilitate obtaining new terminal sites.

— Evaluation of combined pickup and delivery fleets.

— Programs to eliminate delays and congestion (perhaps through expanded TOPICS Programs).

— Allocation of funds to capital projects that will expedite urban goods movement (such as special truckways, and off-street truck loading zones). Under revenue sharing, and the proposed 1973 Highway bill, local communities will have an opportunity to channel funds to the neglected area of urban goods movement.

— Measures to encourage the expenditure of funds by industry to improve urban goods movement. Thus, public matching funds, tax concessions, revised zoning regulations and building codes requiring off-street loading facilities may encourage private business to take constructive action to modify existing facilities, and properly design new ones.

In summary, it is clear that a number of measures may be implemented to improve the flow of goods within the urban area, and increase the productivity of local delivery fleets. There is no one answer to the problem; each local area is unique in nature, both in terms of problems and solutions. The potential benefits from such measures are staggering. If costs of local goods movement could be reduced 20%, this would ultimately produce an annual saving of about $8.2 *billion*, or approximately *$40 per year* for every resident of the United States.

Effective programs will require the full support of the shipping public and the transportation industry, working closely with responsible governmental agencies. Continued dialogue, and a spirit of cooperation, will go far in improving the delivery of goods in urban areas.

ACTION PLAN FOR IMPROVED URBAN GOODS TRANSPORTATION

Shippers

1. Become actively involved with local planning groups, and establish a meaningful dialogue with the appropriate planning group. This might be done through the local Traffic Club, civic organization or Chamber of Commerce.

2. Review ordering and shipping practices to determine when shipments can be consolidated. Minimize the number of carriers used to handle similar shipments.

3. Take measures to facilitate truck loading and unloading by eliminating unnecessary delays. Improve facilities and material handling systems where appropriate. This would include a realistic system of shipping and receiving times, and perhaps an appointment system developed jointly with carriers.

4. Discuss alternative methods of operation with your carrier(s). For example, pallet exchange programs, properly staged loads, revised pickup and delivery schedules and improved paper work processing will all facilitate rapid loading and unloading.

5. In designing new facilities, make adequate allowances for trucks, both at present and future volume levels. This would include off-street maneuver area, and properly designed truck docks.

Motor Carriers

1. Likewise, become involved at the local level. Make known your unique needs and constraints, to both planners and customers.

2. Improve dispatch and control techniques, to ensure that trucks are properly routed and scheduled. Take measures to ensure that drivers and equipment are fully utilized.

3. Review terminal locations to ensure that they are properly sited to serve your customers.

4. Evaluate opportunities for combining local PU & D operations with those of other carriers (perhaps through a cartage agent). This would tend to reduce travel between stops.

5. Review equipment specifications to ensure that trucks are properly equipped for efficient deliveries. Thus, hydraulic lifts, roller conveyors, side-doors, palletized loading, and other devices may be warranted. Equipment constraints which hamper deliveries (long wheel bases, high trailers, lack of side doors, or mechanical breakdowns) should be corrected.

TABLE 4