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From the Editor...

Welcome back to the *Journal of Transportation Management*! Even though the *JTM* is a bi-annual publication, this will be the first and only issue of 1996. Submissions to the *Journal* have significantly declined in number over the past 18 months and, after careful deliberation, the editorial staff decided not to publish another issue until enough high-quality articles had been received, reviewed, edited, and accepted for publication. With this issue, the *Journal* is back on track and you can expect to see two issues in 1997 containing timely and informative articles on topics of interest to professionals in the field of transportation.

A number of important changes to the *JTM* have been made and become effective with this issue. First, this issue of the *Journal* is the last under the capable editorial leadership of Mike Crum at Iowa State University. Mike has served Delta Nu Alpha and the *JTM* well during a very difficult time. He has worked very hard to insure that the quality of the *Journal* has been maintained, even when faced with declining submissions and increasing competition from other academic journals. Mike has also contributed to the process of re-designing the *Journal* and has spent hours on the telephone with me in the discussion and evaluation of proposed changes. With his continued help, the *JTM* will grow in value and reputation and better serve the membership of Delta Nu Alpha. Mike gets a personal thanks from me for making the editorial transition smooth and as seamless as major trauma can be!

With the next issue, I will assume the position of editor and two of my colleagues at Georgia Southern University, Brian Gibson and Steve Rutner, will serve as associate editors. The *Journal* will be edited and published by the Southern Center for Logistics and Intermodal Transportation within the College of Business Administration at Georgia Southern. We are proud that the DNA Board of Directors chose Georgia Southern as the new home for the *JTM* and pledge to continuously improve the content, with the aim of making the *Journal* a leading voice in the transportation industry.

You will notice that the size, shape and overall look of the *Journal* are quite different from previous issues. These are only a few of the changes you will be seeing in

future issues. Look for an increase in the variety of topics covered, editorial pieces by leading transportation educators and practitioners, a greater emphasis upon the managerial implications of the topics covered, book reviews, and special issues under the guidance of a guest editor. If there are other changes that you would like to see, then write to me directly (or call) with your suggestions. We are committed to the continued improvement of the *Journal* and to its recognition as an outstanding transportation publication.

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OBJECTIVES

Editorial Policy. The primary purpose of the *JTM* is to serve as a channel for the dissemination of information relevant to the management of transportation and logistics activities in any and all types or organizations. Articles accepted for publication will be of interest to both academics and practitioners and will specifically address the managerial implications of the subject matter. Articles that are strictly theoretical in nature, with no direct application to the management of transportation and logistics activities, would be inappropriate for the *JTM*.

Acceptable topics for submission include, but are not limited to carrier management, modal and intermodal transportation, international transportation issues, transportation safety, marketing of transportation services, domestic and international transportation policy, transportation economics, customer service, and the changing technology of transportation. Articles from related areas, such as third party logistics and purchasing and materials management are acceptable as long as they are specifically related to the management of transportation and logistics activities.

Submissions from industry practitioners and from practitioners co-authoring with academics, are particularly encouraged in order to increase the interaction between the two groups. Authors considering the submission of an article of the *JTM* are encouraged to contact the editor for help in determining relevance of topic and material.

The opinions expressed in published articles are those of the authors and do not necessarily reflect the opinions of the editor, the Editorial Review Board, Delta Nu Alpha International Transportation Fraternity, or Georgia Southern University.

PUBLISHING DATA

Manuscripts. Four (4) copies of each manuscript are to be sent to Dr. Jerry W. Wilson, Georgia Southern University, P.O. Box 8154, Statesboro, GA 30460-8154. Manuscripts should be no longer than 25 pages, double-spaced. Authors will be required to provide electronic versions of manuscripts accepted for publication. Additional manuscript information can be obtained by contacting the editor.

Subscriptions. The *Journal of Transportation Management* is published two time per year. The current annual subscription fee if $35 in U. S. currency. Payments are to be sent to: *Journal of Transportation Management*, Delta Nu Alpha Transportation Fraternity, 530 Church Street, Suite 300, Nashville, TN 37219.

Martin Theodore Farris, Sr.

Educator, Mentor, Father, and Friend

This issue of *JTM* is dedicated to the memory of Martin Farris. All of us will all miss Martin. We extend our sympathies to the Farris family.

Martin was one of the founding fathers of our field. He touch so many of us either in the classroom or through his tireless support of Logistics and Transportation. He probably never realized the tremendous impact he had on so many of us.

Over the course of 35 years in academia:

- he was recognized with the lifetime title of "Regents Professor" — only 1% of the Full professors at the University may be so honored;
- he published 162 refereed articles in countless journals, (even after five years of retirement he currently has an article under review);
- he taught 13 different courses in transportation and economics; eight of which he created;
- he published five textbooks, two monographs; and had his works translated into French, Italian, Japanese, Taiwanese, and Chinese;
- he served actively in many professional and industry groups ---locally, regionally, and nationally;
- over 4,400 students enrolled in his undergraduate courses as well as over 1,000 graduate students; and,
- he was also Chairman of 22 doctoral dissertations, serving to help educate and influence the lives and careers of students throughout the world.

This short list of highlights only reminds us of how special Martin was. Each of us will remember him for a comment he made, a thought he inspired, or a word of encouragement.

Although Martin's tremendous achievements cannot be summed up in a sentence, perhaps his son does the best job when he said,

"Dr. Farris, YOU made a difference!"

DELIVERY LEAD TIME COMPRESSION: AN INTEGRAL PART OF A TIME BASED STRATEGY

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The objective of this study is to examine factors influencing delivery lead time in a manufacturing environment. It presents the results of a survey of the electronic and other electrical equipment and components industry in California to illustrate the relative importance of these factors in delivery time reduction. The degree of importance of each factor is then compared with the extent of emphasis the survey participants actually placed on the factor in attempting to reduce delivery lead time.

Corporate success in today's global environment has become increasingly dependent on a firm's ability to streamline processes and thereby decrease customer response time. The new and emerging customer-satisfaction mind set demands higher quality product, greater flexibility (in variety and volume), and better service at a competitive price within a shorter and shorter time interval. In this fast-paced global environment, more and more customers are willing to pay premium prices for faster responses to their needs. Even though quality, flexibility, service, and cost are very important factors, they are evolving into given competitive priorities that customers are not willing to compromise. The ever increasing challenge is speed and on-time delivery of customer orders–Time Based Competition (TBC).

Time Based Competition is a strategic approach of achieving competitive advantage through: (1) fast introduction of new technology and development of new products and (2) fast response to customer demands for existing products through the compression of purchasing, manufacturing and delivery lead times.[1] This study emphasizes the second portion of TBC by scrutinizing various aspects of delivery lead time reduction.

DELIVERY LEAD TIME

From a manufacturer's point of view, delivery lead time (delivery cycle) is the elapsed time between when an item is completed and available to be shipped until that item is received by the customer.[2] This time interval typically encompasses order receipt and entry, order processing, order preparation (picking and packing), and order shipment (transit time).[3] The lead time quoted to a customer (customer lead time) is often different (greater) than the delivery lead time. Customer lead time can be as short as the delivery lead time (make-to-stock environments) and as long as the total of product development, purchasing, manufacturing, and delivery lead times (engineer-to-order environments).

Initially, fueled by the application of just-in-time techniques, manufacturers strived to reduce purchasing

and manufacturing lead times. Unfortunately, improvement in speed in one area can be offset by poor performance in another area. For example, in 1982, Toyota discovered that while it was able to produce a car in two days, it took from fifteen to twenty-six days to process the order, get it scheduled, and deliver the car to the customer.[4] Thus, delivery time began receiving an increasing amount of attention as a means of reducing overall response time. A study in the late 1980's indicated a shift in JIT programs focus from manufacturing to delivery lead time. This study indicated that the application of JIT has led to changes in the modes of carriage used for both inbound and outbound movements.[5] Further evidence of the growing importance of time compression has been the development of Quick Response (QR) systems in the retailing and apparel industries. Finally, more recent time based competition strategy (philosophy) is aimed at achieving supply chain integration by eliminating all "non-value-added" activities in business processes.[6]

In the area of logistics, the past two decades brought an increased recognition for an integrated business discipline which resulted in both reduced costs and increased customer service. Forward thinking firms were able to capture and retain market share through better coordination of logistics activities. This was followed by an emphasis on logistics quality aimed at increasing customer satisfaction by adding value to the firm's product via on-time, accurate, undamaged delivery. As part of this process, partnerships developed which provide additional opportunities to improve logistics quality.[7] Currently, manufacturers are striving to become more competitive through a simultaneous improvement of quality of delivery process and compression of delivery cycle.

FACTORS INFLUENCING DELIVERY LEAD TIME

From a logistics perspective, delivery lead time reduction can be achieved through both accelerating its value-added components (e.g., reduction of transit time through selection of appropriate modes of transportation and efficient vehicle routing) and elimination of non-value-added activities (e.g., elimination of the time-consuming, unnecessary administration/paperwork through the application of EDI). Typically, the initial efforts in reduction of delivery lead time, as is the case with all JIT related applications, primarily expose factors which tend to lengthen order delivery. For example, decisions made in other areas of logistics (e.g., location and number of warehouses), by manufacturing (e.g., changes in schedules), or by customers (e.g., changes in orders) can all affect a firm's ability to manage its delivery lead time. Accordingly, this study focused on eleven factors which incorporate the traditional considerations as well as contemporary TBC issues of the integrated logistics management. These factors are: 1) forecasting accuracy; 2) frequency and volume of delivery; 3) modes of transportation; 4) vehicle routing; 5) dis- tance, location, and geographical limitation of the customer; 6) containerization of delivered items; 7) transportation regulation; 8) simplified administration/paperwork; 9) product limitation/characteristics; 10) custom- er order changes; and 11) delivery schedule changes.

Forecasting Accuracy

Accurately forecasting the needs for goods at various supply points can affect the ability of a firm to provide product in a timely manner. Delivery lead time can be reduced if an accurate forecast results in making product available at forward locations (e.g., warehouses). Forecasting is also critical in the use of distribution requirements planning (DRPI and DRPII). Distribution requirements planning translates demand forecasts into a time phased replenishment plan. If stock keeping unit (SKU) forecasts are not accurate, neither is the plan.[8]

Frequency and Volume of Delivery

As frequency of delivery increases, volume of individual delivery declines. One means of shortening delivery lead time is to simply have the product delivered more often from geographically proximate locations. Higher delivery frequency can be achieved through the use of smaller capacity trucks. While there is a penalty in the form of higher transportation cost, this is offset by higher market share and resulting increased profits.[9]

Mode of Transportation

Perhaps the most obvious way to improve delivery speed is to compress transit time. Firms today realize there is a need to increasing the speed of inventory through the logistics pipeline. Transportation modal and carrier selection is an integral part of attaining that speed. However, selection must use models which consider cost in addition to timeliness otherwise what might be considered an easy way to reduce delivery time can prove to be very expensive.[10]

Vehicle Routing

Most manufacturers (industrial good producers with JIT shipments in particular) must often manage delivery of small lot sizes at great speed to their customers (original equipment manufactures). Routing vehicles (e.g., private fleet and common carriers) to connect various nodes of the distribution network (e.g., central warehouse, distribution centers, and customers locations) can profoundly effect transportation distance and, in turn, the delivery lead time.

Distance, Location, and Geographical Limitations of the Customer

Transit time is primarily a function of distance. Location decisions with respect to manufacturing and distribution facilities can have a major impact on delivery lead time. JIT suppliers often locate near major customers in order to be able to respond quickly to customer needs. In addition, suppliers can spot inventory at forward locations using public warehouses to reduce delivery lead time. While inventory requirements may be increased, more accurate forecasting can aid in keeping these increases to a minimum.

Containerization of Delivered Items

JIT manufacturers often use standard size containers to facilitate smooth flow of items between various workstations and efficient transportation of finished goods to their customers. "Standards can reduce variables to a manageable number. Unit loads, gross volumes and weights for 20-foot containers, packaging standards, pallet sizes, and so forth, make planning much easier and results more predictable."[11] Therefore, containerization of delivered items can be used as a means of stabilizing delivery lead time variability.

Transportation Regulation

Depending on the product and circumstances surrounding a shipment, various transportation regulations can act to increase delivery time. While the majority of these may relate to additional paperwork requirements, safety regulations can result in added packing, loading, and shipment preparation time. One factor that may have an impact on the delivery lead time in the future is restriction of delivery times in congested urban areas.

Simplified Administration and Paperwork

This factor relates to order receipt, entry, processing, and assembly which often require extensive administration and paper work. The application of electronic data interchange and automatic identification technology not only increases accuracy, but also reduces the process.

Product Limitations/Characteristics

A product's perishability, bulk, dimensions, and other characteristics can often lead to the need for special handling or packaging. In these cases, better planning is necessary to have appropriate resources available to handle the product. Any delays in making these resources available can delay delivery time.

Customer Order Changes

Customer satisfaction encompasses the delivery of the right product at the right time. "The problem is that customers are notoriously fickle. Just when you think you know what they want, they change their minds. Or worse yet, never make up their minds in the first place."[12] Customer order changes (e.g., changes in design, options, and quantity) create variability in the delivery process and lengthen the delivery lead time. Close cooperation and open exchange of information (partnership) between a manufacturer and its customers should minimize order changes and increase the manufacturer's ability to manage the process variability.

Delivery Schedule Changes

Delivery schedule changes have an effect similar to customer order changes. A change in the delivery schedule of an order (whether initiated by the customer or the manufacture) impacts the production system and logistics function (often with a ripple effect on delivery schedules of other orders) which will lengthen overall delivery lead time.

METHODOLOGY

A questionnaire was designed to provide a variety of information about TBC. It was composed of four groups of questions consisting a total of 228 variables. The first group of questions classified respondents based on type of goods, type of manufacturing process, number of products, number of employees, and annual gross income. This group also indicated purchasing, manufacturing, and delivery lead times as a percentage of total lead time. The next three groups of questions were designed to scrutinized various aspects of customer, delivery, manufacturing, and purchase lead times. This paper primarily concentrates on responses to the delivery lead time questions (the above eleven factors).

The electronic and other electrical equipment and components industry in the State of California provided the frame for the survey. The responses of manufacturing firms with one hundred or more employees and $5,000,000 or more annual gross sales were used to complete this research.

The 1995 edition of the *California Manufacturer Register*[13] and *The American Business Disc*[14] were used to develop the mailing list. The 3612 through 3699 S.I.C. codes were the bases of identifying the appropriate manufacturing firms. A total of 648 manufacturing firms constitute the survey group. Questionnaires were mailed to the firms' representatives such as chief executive officer, president, vice president of manufacturing, and plant manager. Three weeks later a follow-up letter was sent to each of these manufacturing firms. Telephone calls were also made to a randomly selected number of firms to remind them of the importance of this research. All efforts yielded 51 usable responses. The relatively low usable response rate could be attributed to: (1) the comprehensive, exploratory, time-consuming nature of the questionnaire; (2) the multi-disciplinary (purchasing, manufacturing, and delivery functions) nature of the research; and the research delimitation (inclusion of manufacturing firms with one hundred or more employees and $5,000,000 or more annual gross sales).

THE SURVEY RESULTS: EMPIRICAL EVIDENCE

Many practical and interesting results were drawn from the findings of this research. The results related to delivery lead time reduction are presented in this paper. They are divided into four groups: (1) the respondent profile; (2) components of total lead time; (3) factors influencing delivery lead time reduction; and (4) emphasis placed on factors reducing delivery lead time.

The Respondent Profile

Table 1 presents the profile of participating manufacturing firms. These firms were representatives of a cross-section of different processing environments, number of products or variation of products, and annual gross sales. A majority of these firms (74.5%) employed 101 to 500 employees. Finally, these firms, on average, produced significantly more industrial goods (71.2%) than consumer goods (21.0%). Since 60% these firms produced 90% or more industrial goods, conclusions drawn from the data received relate more to the delivery lead time of industrial, rather than consumer goods.

Components of Total Lead Time

Since total lead time, from a TBC perspective, includes purchase, manufacturing, and delivery lead time, firms were initially asked to estimate the percent of total time most commonly consumed by each. Results shown in Table 2 indicated that the percentages of purchase and manufacturing lead times were almost equal and accounted for the majority of total lead time.

TABLE 1
Profile of Participating Manufacturing Firms

Category	Percent	Category	Percent
Manufacturing Process		Number of Products or Variation of Products	
Job Shop	21.6	0-50	17.6
Batch	31.4	51-100	15.7
Repetitive	25.5	101-250	21.6
Continuous	13.7	251-500	7.8
Other	3.9	501-1,000	15.7
Missing Values	3.9	Over 1,000	19.6
		Missing Values	2.0
Number of Employees			
101 to 250	35.3	Annual Gross Sales	
251 to 500	39.2	$5,000,001 to $20,000,000	15.7
501 to 1,000	7.8	$20,000,001 to $50,000,000	33.3
1,001 to 2,500	9.8	$50,000,001 to $100,000,000	19.6
Over 2,500	7.8	$100,000,001 to $500,000,000	17.6
		$500,000,001 to $1,000,000,000	5.9
		Over $1,000,000,000	7.8
Type of Goods (Products)*			
Consumer Goods	21.0		
Industrial Goods	71.2		
Other	7.8		

* The percentages are averaged for all respondents

This illustrates why firms commonly address manufacturing and purchase lead time first when attempting to compress total lead time. However, as previously mentioned, many firms have achieved decreased customer response time in these two areas and are now taking a closer look at the delivery lead time component.

Factors Influencing Delivery Lead Time Reduction

Using a seven-point ordinal scale (1 = not important to 7 = very important), the respondents were asked to indicate their opinion (belief) of the importance of each of the eleven factors discussed previously in reducing delivery lead time in their manufacturing firms. Using a similar scheme, the respondents were also asked to indicate the extent to which their firms currently emphasize (1 = no emphasis to 7 = great emphasis) each factor in reducing delivery lead time.

TABLE 2
Components of Total Lead Time

Category	Percent*
Purchase Lead Time	42
Manufacturing Lead Time	43
Delivery Lead Time	11
Other**	4

* The percentages are averaged for all respondents.

** This category included the product development lead time.

Table 3 presents these factors in descending order of their reported degrees of importance. This table also presents mean scores and ranks of the importance of each factor, mean scores and ranks of the emphasis placed on each factor, mean comparisons (*t*-values and

and two-tail significance) of the two categories of responses (emphasis versus importance), and the Wilcoxon Matched-Pairs Signed-Ranks Test for the two categories of responses (emphasis versus importance).

The top six factors listed, comprise a group of elements which can be considered to have an above average importance in attempting to reduce delivery lead time. The rank and mean value for forecasting accuracy indicates the paramount importance of this factor in enabling a manufacturer to effectively plan for the speedy delivery of orders. This is the core of quick response systems. The availability of current demand data provides a firm with an ability to have products available in the right place at the right time to satisfy customer needs. Of course rapid communication of these data between all parties involved (carriers, suppliers, and customers) is critical in compressing delivery lead time.

Frequency/volume of delivery and simplified administration/paperwork were ranked high–as one might expect–and considered as important ways of reducing delivery lead time. Interestingly enough, these two factors are closely related. More frequent deliveries often require increased paperwork. Unless appropriate technology is utilized and efficient processes are developed to eliminate non-value added tasks, attempts to shorten delivery lead time can be thwarted by multiplying administrative barriers. In this case internal communication must ensure that shipments are not delayed because they are waiting for paperwork.

From a systems perspective, changes in customer orders and delivery schedules can lead to increased variability in various manufacturing processes. Respondents' placing above average degrees of importance on these factors reiterated the importance of process stability. Evidently, participating manufacturers believe that delivery lead time can be reduced in an stable environment, and stability can be achieved through management (reduction) of delivery schedule and customer order changes.

The final factor which ranked above average in importance relates to the physical characteristics of the product itself. Assuming that these characteristics cannot be altered via design changes, reducing lead time would rely on improving the processes required to accommodate a product's special needs. This may relate to loading, packing, or any number of other handling needs.

One of the more surprising results is the low importance placed on transportation related factors. Modal selection, routing, distance, and regulation all ranked toward the bottom. Since transit time is such an important factor in determining delivery lead time, one would assume it would be an important means of time compression. However, the reality is that there are limits upon the ability to compress this time. Once initial improvement in transit time occurs, there are very limited opportunities to further reduce it. If this is the case, responding firms may have already done what is necessary to speed movement and are now focusing on other factors.

Emphasis Placed On Factors Reducing Delivery Lead Time

A comparison of the emphasis placed on each of the above factors with its stated importance reveals a constant belief that attention to these factors is lagging. A lack of sufficient emphasis might indicate that those who make decisions about resources or set priorities are unaware of the extent to which these factors can impact delivery time. Once again, logistics managers are faced with the task of communicating the importance of the integrative logistics activities.

For the six factors which were reported to be the most important in reducing delivery time, five were identified as not receiving enough emphasis. This was particularly true of the two factors which ranked the highest in importance: forecast accuracy and frequency/

TABLE 3
Factors Influencing Delivery Lead Time Reduction

Factors	Importance		Emphasis		Mean Comparison (Emph. vs. Import.)		Wilcoxon Test (Emph. vs. Import.)	
	Mean	Rank	Mean	Rank	*t*-value	Signif.	Z Value	2-Tailed *p*
Forecast Accuracy	5.57	1	4.96	1	-2.97	0.005*	-2.6571	0.0079*
Frequency & Volume of Delivery	4.76	2	4.12	3	-2.85	0.007*	-2.5547	0.0106*
Simplified Administration/ Paperwork	4.55	3	4.11	4	-1.47	0.148	-1.4004	0.1614
Delivery Schedule Changes	4.48	4	4.19	2	-2.10	0.042*	-1.8713	0.0613
Customer Order Changes	4.44	5	3.84	6	-2.75	0.009*	-2.4674	0.0136*
Product Limitation/Characteristic	4.35	6	3.85	5	-2.34	0.024*	-2.3893	0.0169*
Distance, Location, & Geographical Limitation of the Customer	3.42	7	3.11	7	-1.74	0.090	-1.6053	0.1084
Modes of Transportation	3.16	8	3.00	8	-0.98	0.333	-0.9581	0.3380
Containerization of Delivered Items	2.67	9	2.60	9	-0.75	0.457	-0.8891	0.3739
Vehicle Routing	2.60	10	2.32	10	-2.32	0.026*	-2.1339	0.0329*
Transportation Regulation	2.40	11	2.10	11	-1.67	0.103	-1.5297	0.1261

* Two-tail significance $\leq$ 5%.

volume of delivery. Only in the case of simplified administration and paperwork did re- spondents feel that a balanced attention was being given to an important delivery time reduction factor. This is not surprising since order entry, processing, and assembly time (all requiring administration and paperwork) have long been recognized as major elements in determining the length of delivery lead time. Therefore, these elements (in turn, adminis- tration and paperwork) have been the target of technology applications, process improvement, and reengineering. However, manufacturers need to place higher degrees of emphasis on the remaining top five important factors if they wish to further compress their delivery lead times.

The five factors which were ranked the lowest in importance, in general, were identified as being adequately stressed in lead time reduction strategies. Again, the highly visible nature of transportation may be responsible for the attention that has been paid to all but one of these factors in the past, resulting in adequate corporate responses. The single exception was vehicle routing, a factor which is of great importance to firms in a JIT environment. Therefore, even though this factor ranked low in importance, it is seen by some firms as requiring additional attention.

CONCLUSIONS

Traditional means of reducing delivery lead time tend to focus on compressing one of its four major components: Order entry, order processing, assembly, and transit time. Information provided by respondents in this study indicate that other factors may also be important in attempting to decrease delivery lead time and thereby become more responsive to customers. It appears that factors related to transportation and paperwork have been dealt with, to some degree, and are currently being emphasized in lead time reduction strategies. In answering the challenge of time based competition, however, other factors including forecasting accuracy, frequency of delivery, order changes, and delivery schedule changes require additional emphasis. While this study is limited by its focus on a single industry, the concepts discussed may, in fact, be applicable in other industries. In any case,

it is apparent that logistics managers must recognize the fact that delivery lead time reduction may require examining more factors and processes than have traditionally been considered.

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COMBATING TERRORISM AGAINST COMMERCIAL AVIATION

C. Kurt Zorn
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General concern about terrorism and sabotage in the United States has grown in the aftermath of the sabotage of Amtrak in Arizona, the bombing of the federal office building in Oklahoma City, the bomb threat at the New York regional air traffic control center, and the bombing of the World Trade Center. A concomitant concern has developed with regard to the adequacy of security at domestic airports and in commercial aviation. Twice in a three month period in 1995 the Federal Aviation Administration (FAA) increased airport security. In August 1995, the FAA ordered heightened airport security procedures due to concern within the Clinton Administration about the threat of more frequent and more deadly terrorist attacks in the United States.[1] Then, in October 1995, the FAA once again increased airport security due to concern about the visit of Pope John Paul II, progress in the Palestinian and Israeli peace process, and the conviction of ten Muslim terrorists.

Concern with the security of commercial aviation reached an all-time high after the bombing of Pan Am Flight 103 over Lockerbie, Scotland in December 1988. This deadly act of terrorism prompted passage of the Aviation Security Improvement Act of 1990 (1990 Act) which set a number of goals for the enhancement of commercial aviation security. In the early 1990s concern seemed to ebb as acts of terrorism against U.S. targets decreased only to be heightened by the events in Oklahoma City and the explosion aboard TWA Flight 800 in July 1996.[2] There was a realization that terrorists are finding targets in the United States more attractive and attacks on the traveling public were likely to increase.

Heightened commercial aviation security, while good for the safety of the traveling public, is not without its costs. Besides the direct costs associated with employing additional security personnel and equipment are the indirect costs–the opportunity costs–associated with the inevitable delays that accompany more careful screening of passengers and their luggage. Tighter security requires the traveler to allot more time to make flights because curbside check-in is not available, metal detectors are more sensitive leading to more false alarms, more luggage is searched, and gate agents are asking passengers more questions.[3] The obvious question is whether the benefits gained from enhanced aviation security justify the costs.

During the first part of the 1990s strides have been made in the improvement of commercial aviation security in the United States. Despite these advancements, there is a lot yet to be done. This paper provides an overview of developments in commercial aviation security in the United States during the first part of the 1990s, discussing the accomplishments and setbacks encountered, and outlines the challenges that remain.

BACKGROUND

The FAA has responsibility for the safety and security of commercial aviation in the United States. The FAA's approach to ensuring security in commercial aviation has evolved over the years in response to changes in the complexion and frequency of terrorism. The bombing of Pan Am Flight 103 heightened concern about the security of commercial aviation to

such an extent that Congress passed the Aviation Security Improvement Act of 1990.

The 1990 Act underscored concern about aviation security shared by Congress and the general public. It contained many mandates and directives for the FAA including:

- "FAA and the FBI were required to jointly assess the threats to and vulnerabilities of the nation's airports
- FAA was required to review the security programs of foreign air carriers and approve those that provide a level of protection similar to that provided by U.S. carriers serving the same airport
- FAA was required to study the need for additional measures to safeguard the transportation of cargo and mail by passenger aircraft
- FAA was directed to support the acceleration of research to develop explosive detection equipment"[4]

It was hoped these measures would greatly improve commercial aviation security in the U.S. and throughout the world.

The Threat

Clearly the 1990 Act was a direct response to the Pan Am bombing and concern about increased terrorist activity against commercial aviation in the United States. Before discussing the progress the FAA has made toward the objectives set forth by the Act, it is reasonable to ask how real is the threat against commercial aviation.

It is important to understand what is meant by terrorism. A working definition of terrorism has been formulated by the Office and Technology Assessment (OTA). OTA defines terrorism as "... the deliberate employment of violence or the threat of violence by sovereign states or subnational groups, possibly encouraged or assisted by sovereign states, to attain strategic or political objectives by acts in violation of law intended to create a climate of fear in a target population larger than the civilian or military victims attacked or threatened."[5]

In truth, terrorist acts within the borders of the United States have been rare. For example, during the 1987-1992 time period there were a total of 38 terrorist incidents, another 31 suspected terrorist incidents, and 24 terrorist acts that were thwarted. These incidents ranged in severity from relatively simple acts with no injuries or loss of life to significant attacks with injuries and loss of life. The incidents involved a variety of approaches including verbal threats, hijackings, explosives, and the use of incendiary devices. However, the acts tended to be on the more simple end of the continuum.

TABLE 1
Terrorist Activity in the United States, 1987-92

Year	Terrorist Incident	Suspected Incident	Terrorist Acts Prevented
1987	9	8	5
1988	9	5	3
1989	4	16	7
1990	7	1	5
1991	5	1	4
1992	4	0	0
Total	38	31	24

Source: United States General Accounting Office, *Aviation Security: Additional Actions Needed to Meet Domestic and International Challenges* (Washington, D.C.: Government Accounting Office, GAO/RCED-94-38, January 1994), Table 1.1, page 11.

During the past five years, there have been few incidents of terrorism against commercial aviation targets either in the United States or the rest of the world. The majority of terrorist incidents that have occurred have been targeted against the flag carriers of countries which have been experiencing a degree of civil unrest or upheaval. While commercial aviation recently has not been targeted by terrorists, the threat is always present.

Traditionally the source of the threat to commercial aviation has been from explosives contained in checked luggage, carry-on baggage, and mail. There is growing concern that, as advances are made in detecting explosives in checked and carry-on luggage, terrorists may turn to more exotic devices as a way to achieve their objectives against commercial aviation. One such device is the handheld missile, a weapon that is becoming more common in the terrorist's arsenal. Up to now, most missile attacks against civilian aircraft have occurred in areas of the world that have been experiencing insurgencies. During the 1978-93 time span, 15 of 26 attacks occurred in Angola, Sudan, and Afghanistan. These attacks were infrequent over the 1978-93 time span, but their frequency has increased in recent years.[6]

TABLE 2
Incidents of Terrorism Against Commercial Aviation Targets

Year	U.S. Airlines	Foreign Airlines
1990	1	39 (26 Aeroflot)
1991	1	24 (11 Aeroflot)
1992	0	12 (5 Ethiopian Airlines)
1993*	0	1 (Lufthansa)
1994*	0	4

* Estimates.
Source: Air Transport Association Congressional briefing materials.

While the data suggest the threat to U.S. commercial aviation has not been severe, there is reason to be concerned about the future. The potential for terrorist activity in the United States is real, and many believe it is growing. The Federal Bureau of Investigation (FBI) has detected an increase in terrorist "networking" and has identified a growing terrorist infrastructure. This infrastructure, which includes logistics support, equipment, training, and financial aid, is in place and ready to be tapped by terrorist groups. Both the FAA and the FBI believe that, as terrorist acts increase in the United States, airports and civilian aircraft will remain among the most attractive targets.[7]

A recent Department of Defense study on the future of terrorism highlights the concern for commercial aviation.[8] Terrorists no longer seem satisfied with a few casualties; the trend is toward acts that cause mass casualties. The United States already is painfully aware of this trend toward more spectacular acts of sabotage. Terrorists will use all targets they consider vulnerable and appropriate; it seems logical that commercial aviation and the infrastructure supporting the air transport system in the United States will be targeted. Recognizing this threat, a lot of effort and money has gone into improving the security of commercial aviation in the United States.

DEVELOPMENTS IN COMMERCIAL AVIATION SECURITY

The Pan Am tragedy in December 1988 served as an impetus to focus attention on the current state of commercial aviation security. In direct response to the Pan Am incident, President Bush created the President's Commission on Aviation Security and Terrorism. The Commission issued its recommendations in May 1990 and many of the recommendations were included in the 1990 Act. During this same time period, the Office of Technology Assessment (OTA) undertook a major study on the subject of using technology to combat terrorism. OTA undertook an in-depth look at a number of security issues including research and development of explosive detection devices and security at airports. A few years after the OTA study, the Government Accounting Office (GAO) released a series of studies that analyzed the current status of commercial aviation security and identified the challenges that remain.

The OTA Study

In 1989, a number of Senate committees asked OTA to investigate the status of research on technologies that could be used to protect the United States and its citizens from acts of terrorism. The study resulted in two separate reports. The first report dealt with research and development efforts on the federal level to counter terrorism, especially against commercial

aviation, and the state of technology for the detection and prevention of attempts to introduce explosives aboard aircraft.[9] The second report focused on integrated security systems and the human factors in commercial aviation security.[10]

Research and Development in Explosives Detection Systems (EDS).[11] OTA identified two general approaches to explosives detection that were being pursued by the FAA in 1991–bulk detection and vapor or residue detectors. One bulk detection approach, referred to as a nuclear method, relied on ionizing radiation to penetrate the object being studied. In 1991, Thermal Neutron Analysis (TNA) was the most developed of the nuclear technologies, but OTA felt its usefulness was limited.[12] The other nuclear technologies were not promising candidates either because they required accelerators to generate the necessary active particles. Development of an accelerator that would be useful in a real world setting was a long way off.

A second method of bulk detection was the use of magnetic resonance and nuclear quadrupole resonance.[13] OTA did not believe this approach showed much promise in the near term. A third method of bulk detection was the use of x-ray technologies such as the backscatter x-ray and computerized tomography. Backscatter x-ray systems scan "a pencil beam of x-rays across an object and makes two images: the normal transmission image, created by a single detector on the opposite side, and a backscatter image, created by a large detector on the side of the entering beam."[14] Computerized tomography is an adaptation of the medical CAT scan techniques. These methods of bulk detection seemed the most promising of the three bulk detection approaches.

The second general approach to explosives detection involved detecting vapors or residues left by explosives. These detectors could be as familiar as trained dogs or as advanced as technologies like chemiluminescence, ion mobility spectrometry, and bioluminescence.[15]

TABLE 3
Explosives Detection Technologies

***Bulk detectors*:**
Using ionizing radiation
- Nuclear
  - Thermal Neutron Analysis
  - Fast Neutron Analysis
  - Nuclear Resonance Absorption of Gamma Rays
  - Associated Particle Production
  - Pulsed Fast Neutron Analysis
  - Pulsed Fast Neutron Backscatter
  - Nitrogen-13 Production with Positron Emission Tomography
- X-ray
  - Transmission
  - Backscatter
  - Dual or Multi-Energy
  - Computerized Tomography

Using non-ionizing radiation
- Nuclear Magnetic Resonance
- Electron Spin Resonance
- Nuclear Quadrupole Resonance

***Vapor or residue detectors*:**
- Dogs
- Gas Chromatography (GC)/Chemiluminescence
- GC/Electron Capture
- Ion Mobility Spectrometry
- Mass Spectrometry (two-stage)
- Bioluminescence

Source: U.S. Congress, Office of Technology Assessment, *Technology Against Terrorism: The Federal Effort*, OTA-ISC-481 (Washington, DC: U.S. Government Printing Office, July 1991), Table 4-2, p. 39.

Table 4 provides a brief overview of the strengths and weaknesses OTA found with some of the more promising EDS devices. OTA came to the conclusion that, after its review of the "...current state-of-the-art, [it] sees no evidence that any device, currently at the prototype stage, is capable by itself of *reliably* detecting small quantities of plastic explosives in checked baggage."[16] OTA defined "reliably" as a device that had at least a 90 percent detection rate and a false alarm rate that did not exceed 5 percent.

Aviation Security.[17] OTA made a number of recommendations with regard to aviation security. First, because no current or near-term technology appeared capable of providing the profiling and bomb detection technology needed to increase airline security, OTA concluded that an integrated approach which combined a number of different detection technologies would be preferable over one particular detection technology. This approach would allow the different technologies to complement each other because no one technology was able to provide the level of reliability required.

OTA did not recommend a specific configuration for the integrated approach. Instead it provided a conceptual outline of what the integrated system might look like. In the first stage of the system, passenger profiling and an advanced x-ray system would be used. When there was an indication that explosives were present additional scrutiny would be triggered. Stage two of the system would use a different technology, possibly vapor detection. Stage three would use a more elaborate and expensive device such as computerized tomography or TNA. OTA emphasized that the particular system used by an airport would be tailored to the specific needs and characteristics of that airport. OTA thought determination of the optimal configuration for the system would be fairly easy and be dependent on things like peak passenger flow, required throughput rate (how many bags can be processed per hour), cost constraints, acceptable false alarm rate, and room (size and weight of the system).

The second recommendation that OTA made regarding aviation security was that more emphasis be placed on human factors in commercial aviation security. It noted that technology has its limitations and it was unrealistic to expect commercial aviation security to be totally automated. Therefore OTA suggested paying increased attention to passenger profiling.

OTA also underscored the importance of well-trained and highly motivated "screeners"–those individuals who operate the metal detectors everyone must pass through before boarding a commercial aircraft in the United States. These security jobs require repetitive tasks and are boring because personnel are searching for a rare event–the presence of explosives or weapons. Acknowledging that a security system will only be as good as its weakest link, OTA suggested screeners receive better training and that EDS systems automate the boring and repetitive tasks as much as possible.

Third, OTA thought there was adequate promise in the field of aircraft and cargo container hardening to recommend further research and development. Aircraft and cargo hardening would involve modifying cargo containers to absorb shock waves, prevent fragmentation, and to vent pressures; adding cargo bay liners to contain fragments; placing blow-out panels in the fuselage to control skin ruptures and tearing; and closing cavities and pathways between cargo containers and in the aircraft structure that have the potential of acting as conduits of shock waves.

Developments in the EDS Field Between 1991 and Late 1992

In August 1992 Heathrow airport concluded six weeks of tests on the modified Model 101ZZ backscatter x-ray system.[18] Both the airport and developer seemed pleased with its performance during this operational test. It was estimated about 3,600 bags could be scanned per hour by the system and human intervention was needed only if the x-ray detects an object with characteristics of an explosive.

The FAA, in August 1992 altered its policy and began to allow airlines to voluntarily use enhanced x-ray and vapor screening devices to screen carry-on electronic items.[19] Checked baggage could not be screened by these technologies because the FAA believed there were too many limitations associated with these technologies and their use might provide a false sense of security.

This new policy was met with a cool reception among airlines. The airlines expressed disappointment with the lack of attention and resources the FAA was devoting

TABLE 4
Advantages and Disadvantages of Selected Explosives Detection Techniques*

Type	Advantages	Disadvantages
Chemiluminescence	Cost; size; detects plastics; good at identifying particular molecular compounds	Slow; requires vapors or residues
Electron capture	Very low cost; size; may detect plastics	Slow; requires vapors or residues; not good at identifying particular molecular compounds
Ion mobility	Cost; size; may detect plastics	Requires vapors or residues
TNA	Detects plastics; no vapor needed	Large; expensive; high false-alarm rates; inadequate sensitivity
X-ray, dual energy, or backscatter	Cost and size relatively small; can see other weapons; may see sheets or small quantities of explosives	Not specific to explosives; questionable sensitivity to small or thin quantities of explosives
Computerized tomography	Very high 3-D spatial resolution; good for detection of small quantities	Not specific to explosives; looks only at density; slow; large; expensive

* A major concern with technologies that rely on the detection of explosive vapors or residues was the large amount of "background noise" created by the surrounding environment. In other words, the general atmosphere contains elements that are similar to those generated by explosives making it difficult to develop a vapor or residue detector that has the necessary level of sensitivity without a high false alarm rate.
Source: Adapted from U.S. Congress, Office of Technology Assessment, *Technology Against Terrorism: The Federal Effort*, OTA-ISC-481 (Washington, DC: U.S. Government Printing Office, July 1991), Table 5-1, p. 62.

to explosive detection system development. They pointed out while the FAA had been slow in evaluating and testing devices, European countries have been quite active. Over 52 Egis vapor detection systems had been ordered and 21 machines were already in operation at 12 European airports. In addition, airline officials expressed concern that the explosive detection systems under development would be very costly.[20]

The GAO Studies

The Aviation and Security Improvement Act of 1990 required the FAA to have EDS in place by November 1993. Despite a sizable increase in the FAA's security research and development budget and the opening of the FAA's Technical Center in Atlantic City, the FAA missed the deadline. In fact, it appeared the FAA was years away from meeting the objective. This prompted various members of Congress to ask the GAO to update them on progress with EDS. In addition, two other requests for reports on subjects in the aviation security area were made.[21]

Explosive Detection Systems. The FAA has a central role in developing new security technology. To accomplish this objective the FAA "...(1) establishes performance standards for equipment, (2) selects the mix of technologies for development, (3) provides oversight and technical assistance to contractors, (4) tests equipment to ensure that it meets the performance standards, and (5) certifies (approves) the equipment as suitable for airlines' use."[22] Obviously the FAA has a lot of responsibility and a huge amount of risk. Development of EDS involves new and untested technology and it is difficult to predict how an idea that is conceptually sound and works in a laboratory setting will perform under realistic testing conditions.

Unfortunately, the FAA was not able to meet the November 1993 deadline set forth in the 1990 Act. In fact, there were no devices in operation at airports that had not been approved and in use before the Pan Am bombing in 1988. Compounding the problem, the FAA was unable, as of early 1994, to predict when an EDS capable of meeting its requirements for detecting sophisticated explosives in checked baggage would be approved. Technical difficulties were cited as the reason for the delay:

> "As of December 1993, FAA had 40 research explosive detection projects, including 14 prototype units, 4 of which are suitable for screening checked baggage. Our review of the development status of the 14 prototypes showed that 9 had been delayed–by 1 to 18 months–because of technical problems. Furthermore, FAA has conducted laboratory tests on only seven devices; none fully meets FAA's performance standards. FAA officials said that they expect to have five additional advanced prototypes available for testing in fiscal year 1994 but could not estimate when the new devices would be certified for industry use."[23]

Another criticism leveled at the FAA was its failure to place much emphasis on systems integration when technology is approved for EDS use. While the FAA endorsed the idea that combining systems, as recommended in the OTA report, makes sense, it believed the task of integration should be left to the airlines. Because the airlines ultimately are responsible for the security of their passengers, the FAA suggested they were in a better position to assess their security needs and the needs of the airports they service.

The GAO found this line of reasoning faulty for a number of reasons. First, many potential software and hardware problems could be avoided if integration of systems is promoted from the very beginning instead of attempting to integrate after the technology is developed. Second, EDS technology most likely would continue to evolve and the airlines may not be the correct group to ensure upgrades and improvements are made in EDS. Third, the FAA's approach only seems logical if there are many competing technologies to choose from. This, of course, did not appear to be a reasonable assumption because not one device had been approved by early 1994. Finally, it is questionable whether the airline industry has the financial resources to conduct the research and analysis necessary for integration.[24]

Aircraft Hardening. Aircraft hardening began to receive a fair amount of attention by the FAA in 1992, receiving a dedicated research and development funding line in fiscal year 1993. The FAA and the early tests indicated it was feasible to contain the effects of explosions. Concerns remained about the cost, weight, and durability of the new luggage containers. Also, due to the size of the prototypes the hardened containers only could be used on wide-bodied aircraft. Wide-body aircraft only make up 29 percent of the aircraft worldwide while almost 75 percent of the bombings between 1971 and 1991 occurred on narrow-body aircraft.

Unless the weight and durability concerns with regard to blast resistant luggage containers are remedied, airlines most likely will not voluntarily replace worn out luggage containers with the more secure ones. If these issues cannot be solved, the FAA probably will have to mandate the containers.

Another facet of aircraft hardening is blast management. Blast management involves designing aircraft technology that will allow an aircraft to withstand internal explosions. At the time of the GAO report, little progress had been made in this area.[25]

The Certification Process.[26] Another area that came under close scrutiny by the GAO was the process the FAA set up to approve explosive detection systems. One major criticism the GAO had with the process was its lack of operational testing. The FAA claimed operational testing would add both time and cost to the

TABLE 5
FAA's Security RE&D Budget, Fiscal Years 1988-94 ($ millions)

Program	1988	1989	1990	1991	1992	1993	1994
Explosive Detection	$9.6	$9.9	$17.0	$30.3	$27.3	$26.4	$22.8
Airport Security	0	0	0	$2.0	$4.2	$4.0	$2.5
Aircraft Hardening Program	0	0	0	0	0	$4.5	$7.8
Human Factors	0	0	0	0	0	$1.0	$2.8
Total	$9.6	$9.9	$17.0	$32.3	$31.5	$35.9	$35.9

Source: United States General Accounting Office, *Aviation Security: Additional Actions Needed to Meet Domestic and International Challenges* (Washington, D.C.: Government Accounting Office, GAO/RCED-94-38, January 1994), Table 3.1, page 41 and United States General Accounting Office, *Aviation Security: Development of New Security Technology Has Not Met Expectations* (Washington, D.C.: Government Accounting Office, GAO/RCED-94-142, May 1994), Table 1.1, page 11.

approval process, things critics were already complaining about. In lieu of its own operational tests, the FAA was relying on contractors to perform operational tests.

There were a number of difficulties associated with this arrangement, according to the GAO. Contractors may not be conducting objective, realistic tests; they may be using a laboratory prototype instead of the final market model and the performance may vary dramatically between the two types of machines; most importantly, the FAA was not inspecting the testing conditions nor witnessing the tests, meaning it had no way to verify the contractors' tests.

Another major criticism of the certification process was the lack of reliability standards for the devices being tested. In essence, the FAA could approve an EDS without having any idea how often the system would be out of service. The airlines expressed great reservations with this omission because of the effect unreliable security equipment could have on their performance and operations. The FAA countered that it was too difficult to develop reliability standards, and it would lengthen the approval process if it did. The GAO pointed out that other government agencies, such as the Department of Defense, routinely develop reliability standards for new technology basing the standards on the operational needs of the department.

A third criticism of the approval process was the lack of performance standards for trace detection systems. As late as March 1993 the National Academy of Sciences, which was under contract to the FAA to set performance standards, reported it could not achieve the objective. The Academy cited the difficulty in distinguishing between "...very small traces of explosive material and much larger quantities of other materials in an airport terminal."[27]

Access Control.[28] Access control has been an important component of commercial aviation security in the United States for a number of years. In 1989 the FAA passed stringent regulations governing access control, and the FAA has required more airports to adhere to the regulations over the intervening years. By August 1994, 258 airports were required to "...(1) ensure that only authorized persons gain access to secured areas, (2) immediately deny access to persons whose authorization is revoked, (3) differentiate between persons with unlimited access to the secured area and persons with only partial access, and (4) be capable of limiting access by time and date."[29]

While these regulations seem to be a sensible component of an overall commercial aviation security plan, the cost of adhering to the regulations has greatly exceeded the FAA's own cost estimates. Originally it was projected the costs to meet the regulations would be $211 million for the 1989-98 time span. More recent projections, which include actual costs already incurred, amount to $654 million for the 1989-98 period.[30] Not surprisingly, the costs of access control have been a major concern of airlines which must bear the financial burden.

The reason for these greatly escalated costs, according to GAO, is the FAA's lack of sufficient guidelines and standards for airports to follow while trying to adhere to the regulations. As a result, many airports have purchased access controls that provide a level of control significantly above what is required. Also, many airports contracted with vendors to develop hardware and software for access control systems and now are at the mercy of the vendors because the system is proprietary. In other words, many airports cannot "shop the competition" for maintenance or upgrades because there is no competition.

Similar Security on Domestic and International Routes. The 1990 Act required the FAA to ensure a similar level of protection for U.S. citizens traveling abroad as is provided to those traveling domestically. International security standards generally are less stringent than the ones set by the FAA. The 1990 Act "...permits FAA to accept a foreign carrier's security program only if FAA determines that the program provides a level of protection similar to that provided by U.S. carriers serving the same airports."[31] Despite passing regulations in 1989 that require foreign carriers flying to or from the United States to get their security plans approved by the FAA, there still exists a large discrepancy between security on domestic carriers flying international routes and foreign carriers flying the same routes.

The major stumbling block, according to the FAA, is a diplomatic one. The FAA believes many foreign governments would balk at the United States imposing its standards on their countries' carriers. In addition, the FAA argues that the emphasis should be on the airport the international carrier is flying from rather than the airline itself. Levels of security may vary widely on the same airline depending on what airport the airline is departing. Therefore the focus should be both on international airline security plans and on location. Obviously, this makes FAA's task much more complex and more costly.

The Air Transport Association (ATA) is very concerned with the inconsistency in domestic and international security. While their primary concern is security, the ATA also is concerned about the competitive disadvantage created for domestic carriers by the more stringent security regulations. Table 6 outlines the argument fairly well underscoring the rather steep opportunity costs placed on customers of domestic carriers relative to customers of international carriers serving the same routes.

Recent Developments

In September 1994 it was reported the United Kingdom's Transport Department had set late 1996 as a deadline for screening all baggage carried in the cargo hold of all international commercial flights.[32] This rule affects 50 airports in Great Britain. It requires airports either to inspect 100% of checked baggage by hand, subject all bags to conventional x-rays and search 10% of the bags by hand, or use an automated explosive detection system.

Airports in the U.K. have been taking the lead in improving the screening of luggage. BAA Plc., the private company that operates seven airports in the U.K. including Heathrow and Gatwick, just concluded an 18 month trial of a five-tier screening program at Glasgow airport in 1994. Results indicated that about 80% of bags are cleared at the level one while the other 20% are sent on for further testing. Level two involved a combination of automated screening by dual-energy x-ray devices and close inspection by a human operator. About 1% of the bags originally checked required further screening past level two.

TABLE 6
Differences Related To FAA Security Program

	U.S. Airline	Foreign Flag Airline
1. Passenger processing at airport		
* Security interview at point of baggage acceptance	2-5 minutes - all passengers	Not Applicable
* Physical search of baggage and carry-on items	5-20 minutes - selected passengers (sometimes conducted in special facilities)	Not Applicable
* X-ray of baggage	Required for all checked baggage	Not Applicable
* Security questions at gate	All passengers	Not Applicable
* Total number of passenger processing points including immigration	4-5	2
* Total processing time prior to flight departure	90-120 minutes average	20-30 minutes average
2. Airport terminal facilities		
* Visible security barriers at check-in	Required	Not Applicable
* Check-in counters	Usually segregated in least accessible areas.	Prominent, convenient locations
* X-ray equipment	Often cramped into check-in areas.	Not Applicable
* Off airport check-in-rail stations, cruiseships, hotels, etc.	Generally prohibitive due to security requirements.	No Constraints
* Gate areas	Sterile separation required.	Passenger movement not restricted.
* Aircraft parking locations	May be limited by security requirements, i.e., remote parking.	Flexible
3. Aircraft Servicing		
* Screening of service personnel	Required	Not Applicable
* Cabin searches	Required	Not Applicable
* Guarding of aircraft and cabin during servicing	Required	Not Applicable
* Overnight parking	Sealing and/or guarding of aircraft	Not Applicable
* Catering and cabin supplies	Guarded and/or guarding of aircraft	Not Applicable
* Aircraft turn times	Longer serving time due to security, impacts aircraft utilization	Not Applicable
4. Cargo	Special document and shipper verifications	Not Applicable

Continued . . .

Continuing TABLE 6
Differences Related To FAA Security Program

	U.S. Airline	Foreign Flag Airline
5. Operational Performance		
* Positive passenger bag match	Required	Not required, some carriers conduct bag match on intermittent basis
* Offload of baggage for missing passengers	Required	Several carriers require
* On-Time performance	Impacted by above procedures	Generally not impacted
6. Service Enhancements		
* Advance check-in	Clearance through security measures negates convenience of advance check-in	Service convenience can be offered with advance boarding passes
* Self-check-in and other automation/"ticketless" service	Precluded from full benefit due to security requirements	No Limits
* Expedite or premium service handling	Limited by security requirements	No Limits
7. Customer Reaction		
* Complaints	Written, verbal complaints regarding inconvenience, intrusiveness, or even discrimination	Not Applicable
* Claims	Claims or lawsuits regarding alleged harassment or discrimination	Not Applicable
* Choice of carrier	Security measures cause passengers to avoid U.S. carriers	Benefit from customers diverted from U.S. carriers

Source: Air Transport Association, Congressional briefing materials.

The Egis explosive vapor detector was used for Level 3 screening, and by the end of this level approximately 99.9% of the bags checked were cleared. The remaining 0.1% of the total bags entering the screening system were hand searched in the presence of their owners. If an explosive was detected, the bag entered level 5 which consists of calling in explosive ordnance officials to deal with the situation.[33]

More recently it was reported that full-scale tests on a quadruple resonance EDS were commencing in London.[34] The QSCAN-1000 can be used to inspect checked luggage for explosives, producing either a pass or fail signal. Therefore, it does not require any operator interpretation of results. In a one-week field test at Los Angeles International Airport in late 1995, the QSCAN-1000 performed quite well.

While Great Britain and the rest of Europe continue to make progress in the testing and use of EDS, the United States lags behind. Rather than relying on operational testing like the U.K., the U.S. continues to rely on laboratory testing as the crucial step in the certification process. FAA's use of this approach can

be attributed to the requirement in the 1990 Act that a system must be certified before the FAA administrator can mandate its use. Not surprisingly, U.S. airlines are reluctant to voluntarily invest much time or resources in field testing an EDS that ultimately may not receive FAA approval. This means the FAA has little leverage to convince airlines to perform field tests.[35]

On December 9, 1994, the FAA certified its first EDS. The system certified was the CTX 5000 which "...uses transmission x-ray data to acquire an overall map of the objects in the luggage. It then positions strategic computer tomography slices to identify objects that may be explosives. The technical challenges of increasing the size of the scanner opening to accommodate large bags and engineering a constantly rotating (rather than reciprocating) gantry were solved, making it possible to scan passenger bags in seconds rather than the minutes previously required for a medical scan."[36] The certification was the culmination of more than nine years of research and over $8.6 million spent by the FAA.

The next step for the CTX 5000 is at least two operational trials at different airports and each lasting one year. The purpose of the trials is to help anticipate and solve some of the operational challenges that will be faced as the EDS is integrated into baggage handling systems. The FAA estimates it eventually may cost airlines around $500 million to install the CTX 5000 if the FAA chooses to mandate its adoption after the trials end in 1997.[37]

There has been some recent progress in the aircraft hardening area too. A container has been developed that can withstand the force of an explosion that is greater than the one that downed Pan Am 103 in 1988. Also, the prototype container addresses the airlines' concerns with regard to maintenance and the weight of the container is close to the range deemed acceptable.[38]

CONCLUSIONS

While the threat against U.S. commercial aviation remains relatively low, the possible consequences of such an attack are frightening. The World Trade Center and Oklahoma City bombings highlighted the type of damage and casualties terrorists can inflict when they put their minds to it. It does not take much of a stretch to imagine commercial aviation is a tempting target for anyone bent on wreaking havoc and injuring many people with a single explosive device.

Since the Pan Am tragedy in 1988, a lot of attention has been focused on research and development to improve commercial aviation security. There has been progress but it has been slower than most anticipated. General concern has been voiced about the disappointing pace of EDS development and implementation. The FAA missed its deadline by more than one year, certifying its first EDS in December 1994 instead of November 1993 as required in the 1990 Act. Many reasons have been cited for this delay ranging from the FAA not directing the appropriate level of resources or attention to research and development to the daunting technological challenges it has faced in developing EDS.

Another major area of contention involves the integration of EDS. Despite OTA's conclusion that an integrated approach is the only way to proceed and FAA's admission that this was the correct conclusion, the FAA is doing little, if anything, to promote integration. Instead, it is relying on the airlines, who are responsible for the safety and security of their passengers, to decide how best to achieve integration.

The experience with access control should be sufficient to convince the FAA it should re-think its approach to integration. Its failure to set standards and issue guidelines for airlines and airports to follow as they worked to meet the access control regulations has been blamed for the runaway costs of access control.

Taking a similar "hands off" approach to integration raises the probability that enhanced security will be more costly than it would be if the FAA took a leadership role.

A third area of concern is the fact that European countries seem to be way ahead of the United States in the field testing and utilization of EDS. Part of the lag can be attributed to the requirement in the 1990 Act that the FAA must certify a system before it mandates its use. Another contributing factor to the lag is that fact that airlines are responsible for security in the United States while the government generally is responsible in Europe. Airlines are understandably reluctant to take the lead in EDS development and testing due to the high degree of risk associated with the new technology.

Also, it is reasonable to believe there are economies of scale in security technology implementation. The implication is that a more centralized approach to security may be more cost effective. It is not difficult to imagine that one system designed for a particular airport makes more sense than separate systems for each airline serving a particular airport. In reality, security systems generally are designed for the entire airport, but the current arrangement requires lengthy negotiations among the airport and the airlines serving it to arrive at a security plan acceptable to all. It seems logical to vest the responsibility for designing an integrated security system with the airport management, encouraging them to coordinate with the airlines and the FAA. This approach may result in more risk taking with regard to the field testing of EDS, possibly closing the technological gap with European airports.

One thing is clear, enhanced commercial aviation security is costly. In the current budget-cutting atmosphere it is naive to think the FAA will receive additional resources to achieve its security objectives as quickly as most would like. Therefore, the FAA will have to continue to prioritize tasks meaning it will devote time and resources to particular security objectives at the expense of others. This, in turn, will leave plenty of room for disagreement as not everyone will agree with the FAA's priorities.

At some point, the question should be posed: "Do the benefits from increased security warrant the costs?" Congress is implicitly asking (and answering) this question as it revamps the welfare system, Medicaid, and Medicare. It only seems logical the same test ought to be applied to commercial aviation security. The ensuing debate should be quite interesting!

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GETTING OUT THE MESSAGE: MEDIA AND MESSAGE FOR EFFECTIVE DRIVER RECRUITMENT

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The challenges facing the motor carrier industry in the mid-nineties serve notice that there is no such thing as "business as usual." The 1980s were marked by the opportunities and challenges presented by the abrupt introduction of the "marketing era" and "free entry" brought about by the passage of the Motor Carrier Act of 1980. Carrier management was forced to negotiate in an environment of increased competition, over capacity, and shipper demands for higher levels of customer service. At the same time, they were given new tools such as multi-modal ownership, route freedom, and negotiated contract terms to meet the higher service expectations of shippers.

The rapidly changing operating environment of the 1990's has been characterized by the introduction of a new set of uncertainties. Recognition of logistics as the last frontier for cutting costs and creating competitive advantage has led to an emphasis on developing integrated supply chains. An increased use of third parties and contract logistics, rapid strides in the development and use of technological tools, and development of long term supply chain relationships have come as a direct result. These changes are taking place within the context of a greater global orientation with its characteristic challenges of time and distance, facility and technological availability, and political and regulatory concerns.

Operating within these environmental constraints has placed increased service demands on motor carriers called upon to supply the transportation links between supply chain members. The carrier's ability to meet those service demands in many cases hinges on the performance of the driver.

OVERVIEW

Studies have documented the importance of the performance of contact personnel for actual service delivery and customer perceptions of service quality.[1]

There is increased pressure on today's workforce to deliver the level of service demanded by customers. For motor carriers, driver performance may be critical to the successful fulfillment of customer expectations.[2]

The importance of contact personnel in the delivery of services highlights the need for motor carriers to develop and maintain a skilled and stable driver pool.[3] Yet, driver turnover rates continue to be in excess of 100% per year for many carriers.[4] This means that carrier management must continuously seek to attract and retain qualified drivers.[5]

Attracting drivers and retaining them represent two separate issues. Retention concerns the efforts made by the carrier to determine the incentives and working conditions needed to retain those drivers who are satisfactorily meeting the requisite performance standards. Recruiting concerns the communication of employment opportunities and conditions in an effort to attract drivers who are qualified, willing, and able to perform the tasks necessary to meet the standards of performance mandated by the carrier and the carrier's customers.

Recruitment advertising studies range from the development of an "Applicant Attraction Strategy" [6] to determining the most appropriate advertising messages.[7] Studies have also focused on the use of the individual communication methods. Magnus noted that while the same basic communication methods are being used, there has been a move to use more innovativeness and creativity to achieve the desired results.[8] Examples of this include the use of direct mail, televised interviews and cooperative programs with training institutions.

DESCRIPTION OF THE STUDY

Recruiting costs may vary for different companies. However, those costs which are a part of finding and preparing a driver to fulfill his/her role as the provider of transportation services include; advertising costs, recruiter travel, referral bonuses, the recruiter's salary and benefits, and any training and administrative costs related to preparing the driver to assume his/her role as a qualified service provider. A conservative estimate of these costs ranges from $3,000 to $5,000 per driver.[9] Considering the substantial nature of these costs, the need to develop an efficient recruiting program becomes evident.

The present study examines the effectiveness of recruiting communications for attracting qualified drivers. This will be accomplished by (1) determining which communication methods and messages are being used by members of the industry, and (2) investigating the effectiveness of these methods and messages for attracting qualified, employable drivers.

The Sample

A survey was sent to the person most directly responsible for driver recruitment at the 517 motor carriers listed in the *Traffic Management* directory of "Motor Carrier Services". This represents the universe of carriers listed excluding local cartage companies. It was felt that this listing provided a representative sample of carriers actively meeting the challenges of shippers' expectations in a highly competitive environment. Our respondents were asked to respond to a series of questions concerning the communication methods used to attract prospective drivers. These questions were designed to determine the means used to communicate job availability, message content, and the effectiveness of the communication process.

Twelve surveys were returned as undeliverable. Sixty-two of the remaining 505 carriers responded with completed surveys. This represents a 12.2% response rate. While the response rate was somewhat low, the respondent profile reveals a fairly diverse population. (See Table 1.)

Respondent Profile

Thirty-seven percent of respondents described themselves as regional carriers while 61.3 percent considered themselves to be national in scope. A similar split was observed between TL and LTL with 62.9 percent describing themselves as TL only and 8.1

TABLE 1
Profile of Survey Respondents

Coverage		
National		61.3%
Regional		37.1%
Local		1.6%6
Service		
TL only		62.9%
TL/LTL		29.0%
LTL only		8.1%
Intermodal		41.9%
Size		
	Range	Median
Drivers	9 - 2700	173
Power Units	1 - 1750	180
Customers	5 - 6000	150
Non-union	90.3%	
Union	8.1%	

percent describing themselves as LTL only. The remainder of the respondents, 29 percent, indicated that they have a mix of TL and LTL traffic. Intermodal operations were part of the service mix of 41.9 percent of the respondents. Company size was indicated through the number of power units being operated, the number of drivers employed, and the number of customers being served. The predominant characteristic of our respondents was that over ninety percent were nonunion.

RESULTS OF THE STUDY

The first question addressed by this study was: What means of communication are being used to attract drivers? Respondents were given a choice of 15 print, electronic, personal, and agency communication methods from which to choose. They were asked to indicate, using a scale of 1 to 5, how frequently they used each communication method. Communication methods which were not used would be rated as a 1, while those frequently used would be rated as a 5. Respondents were also asked to indicate if they used any methods other than those listed. There were no indications that other methods were being used. (See Table 2.)

TABLE 2
Communication Method

Method	Mean	S.D.
Recruitment by Current Drivers	4.16	.95
Local Newspapers	4.03	1.32
Other Newspapers	3.42	1.41
Trucking Trade Publications	3.07	1.67
Notices at Truck Stops	2.39	1.28
Flyers/Handbills	2.32	1.37
Messages on Company Trailers	2.20	1.61
State Employment Offices	1.90	1.11
Notices at Local Schools	1.76	1.18
Billboards	1.68	1.14
Radio	1.63	1.01
TV - Cable	1.45	1.16
Private Employment Agencies	1.44	.77
General Magazines	1.32	.83
TV - Local	1.25	.73

The most frequently used communication method was word-of-mouth communication from current drivers. The second, third, and fourth most frequently used communication methods were local, other, and trade newspapers.

The next question was, How effective are the various methods of communication for attracting qualified driver candidates? To answer this question, managers were asked to evaluate the effectiveness of the communication methods they used for attracting driver candidates deemed to be qualified and hirable according to their company guidelines. (See Table 3) Respondents were asked to rate each method from (1) for least effective to (5) for most effective. They were asked to respond with a 0 if they did not use this method of communication.

Respondents indicated that the most effective means of communication is the personal interaction between present drivers and prospective drivers. Local newspapers were indicated to be the second most effective communication source. Other newspapers and trade publications were also judged to be effective means for attracting qualified, employable drivers.

TABLE 3
Communication Effectiveness

Method	Mean	S.D.
Recruitment by Current Drivers	3.42	1.64
Local Newspapers	3.35	1.74
Other Newspapers	2.90	1.71
Trucking Trade Publications	2.23	1.87
Flyers/Handbills	1.59	1.67
Notices at Truck Stops	1.56	1.49
Notices at Local Schools	1.06	1.39
Messages on Company Trailers	1.05	1.39
Radio	.84	1.27
State Employment Offices	.80	.95
Billboards	.70	1.13
Private Employment Agencies	.59	.90
General Magazines	.57	1.28
TV - Local	.43	1.02
TV - Cable	.33	.85

The final question posed was, What message is being used to communicate the desirability of being employed by a particular carrier? The assumption could be made that in order to attract qualified drivers, carrier management should address issues in their advertising that were of interest to this segment of the truck-driving population. Respondents were asked to rate 15 factors from (1), not important, to (5), extremely important. (See Table 4)

TABLE 4
Message Elements

Element	Mean	S.D.
Wages	4.34	.79
Company Reputation	4.30	.85
Equipment Condition	4.11	1.03
Time **NOT** on the Road (Time Home)	4.10	1.04
Health Benefits	3.97	1.12
Equipment Type	3.79	1.14
Access to Upper Management	3.56	1.15
Pension Benefits	3.28	1.12
Freedom from Direct Supervision	2.92	1.16
Vacation Time	2.70	1.04
On-the-Road Expenses	2.60	1.09
Advancement Opportunities	2.35	1.12
Extra Training on Job	2.31	1.07
Sick Leave	2.08	.87
Sign-up Bonus	1.98	1.21

The factors which carrier management identified as being of greatest concern to drivers included pay and benefits, working conditions, and company integrity. The two highest ranking pay/benefits factors are actual pay and home time. These were closely followed by health benefits.

Working conditions can also have a powerful impact on job satisfaction. Many carriers have made considerable investments in equipment over the last few years. Recruitment messages reflect the importance that management attributes to operating equipment that meets shipper needs and DOT regulations as well as being attractive to drivers. Both equipment type and condition are considered to be factors which would attract driver applicants. Considering the nature of the job, equipment has a considerable influence on general working conditions and impacts the driver's ability to complete the assigned task.

The final consideration which managers feel is important to drivers is company integrity. Company integrity includes both the carrier's reputation and the approachability of management. Reputation conveys a dual message of stability and reliability, indicating that promises made will be honored. Management approachability signals the driver as to his/her relative importance to the carrier.

DISCUSSION

The results of this study show that changes are occurring in the use of communication methods to recruit qualified, employable drivers. Information gathered in a previous study employing the same sample was compared to the present results to determine the changes that have occurred between 1989 and 1996.[10] (See Table 5)

Media Usage

The upward trend in newspaper usage indicates that classified advertising in the employment opportunities section of the newspaper has been and remains the predominant media used for communicating to pro-

TABLE 5
Communication Use: 1996 and 1989

Newspaper		Trade Pub		Truck Stop		Current Drivers	
1996	1989	1996	1989	1996	1989	1996	1989
83.8%	79.1%	32.2%	10.1%	6.6%	18.2%	96.7%	96.0%

spective employees. However, there has been a marked rise in the use of trade publication advertising and a decided decline in the use of employment messages posted at truck stops. This may be an indication that because carriers require drivers that are:

1. reliable,
2. capable of using sophisticated communication and tracking equipment, and
3. able to meet stringent federal qualification standards,

drivers are becoming regarded more as professionals and less as commodity workers. If this is true, it is not unreasonable to expect that as professionals they might be expected to read professional publications, e.g. trade publications. These trends indicate that formal print advertising methods continue to be the most productive media for conveying information regarding employment opportunities. This undoubtedly stems from a combination of factors including the ability to more accurately target the market, the high pass-a-long rate, and the relatively low price per exposure.

Current Drivers As Recruiters

The study results indicate that the use of current drivers to recruit new drivers is gaining in popularity. Over ninety-six percent of our respondents indicated that they made use of this method of communication on a regular basis. This response rate was also reported in the 1989 study. However, 78.7% of carriers used it frequently or most frequently in 1996, an increase over the 66.9% reported in 1989. The upward trend in the use of current drivers to recruit new drivers is undoubtedly due to past positive results. Fifty-six percent of the respondents that used current drivers as recruiters in 1996 ranked this method as being effective/most effective for recruiting qualified driver applicants. These results are not unexpected considering the personal nature of the exchange between drivers. This method of communication allows for a dyadic exchange between equals where specific questions and concerns can be discussed prior to the prospect contacting the personnel/hiring office of the carrier. In addition there is ample opportunity for this exchange to take place at rest areas, truck stops, and using the CB radio.

As an indication of how much emphasis is placed on personal recruiting, seventy-nine percent of our respondents have in place a reward or bonus system for those drivers recruiting a hirable new candidate. The rewards range in size from $50 to over $1,000 with a median reward of $250. This provides a positive incentive for present drivers to seek out others who will make a positive contribution to the company. In addition, this affords current drivers the chance to select other drivers with whom they would like to work.

Message Appeal

The message, especially in non-personal communications, should appeal to the target audience and generate the desired response. This is accomplished by appealing to potential applicants on the basis of their most urgent concerns. The results of the survey indicated that eight factors were judged by carrier management to be important to drivers. These factors were then emphasized in recruitment communications. In the 1989 study, managers were

asked what factors they used most frequently. The assumption was that the message deemed to be the most important would be the one that was most frequently used. (See Table 6.)

TABLE 6
Message Elements:
1996 and 1989

Components	Very/ Extremely Important 1996	Frequently Used 1989
Pay/Benefits		
Wages	87.1%	79.1%
At-home-time	80.6%	43.9%
Health Benefits	72.6%	66.9%
Pension	37.1%	N/A*
Equipment		
Condition	78.4%	78.4%
Type	62.9%	N/A*
Company Reputation		
Reputation	82.3%	76.4%
Access to Mgmt.	54.9%	N/A*

* Not asked in the 1989 study.

Richard, Lemay and Taylor[11] surveyed 1500 irregular route truck drivers to determine the factors which were instrumental in their decisions to leave their present employer. The three most significant factors identified by drivers were the attitude and actions of the dispatcher toward the driver, top management and human resources managements' competence and fairness regarding driver interviews, evaluations, and pay, and drivers' perceptions that they were being treated more or less fairly than drivers at other carriers.

Pay/benefits package. The initial concern of most employees is the pay and benefits package that is offered. Wages were considered to be the most important factor comprising the driver's pay/benefits package with 87.1 percent of managers rating it as very important or extremely important to mention wages as part of the recruiting message. Seventy-nine percent of managers in the 1989 study indicated that they frequently mentioned wages in their recruiting message.

Driver at-home-time was closely ranked with pay in importance. By 1996, 81% of managers recognized the importance of getting drivers home on a regular basis as compared to only 43.9 percent of managers in 1989. Carrier management is finding that in order to attract a stable workforce, time-at-home must be considered as part of the total compensation package. This represents a change from the 80's when not being home was considered to be part of the job with very little effort made to schedule regular runs for drivers.

The third component of the pay/benefits package considered to be important by managers was the availability of health benefits. This benefit was rated as very/extremely important by 73 percent of our respondents. In 1989, 66.9 percent of managers felt that this was important to drivers. As health care costs continue to rise, this component of the benefits package could be expected to increase in importance.

Pension benefits are considered to be very/extremely important by only 37.1 percent of managers. Pension availability was not included in the 1989 study. The availability of pension benefits could be expected to gain in importance as carriers develop a more stable, professionally-oriented driver force as these benefits would be more attractive to those drivers who are interested in long-term employment.

Equipment. The second element stressed in recruiting communications concerned the equipment which drivers will utilize. Drivers are as concerned with the quality of the tools with which they must work as they are with their pay and benefits. The carrier's equipment sends many messages. For the driver, the equipment, tractor and trailer, which he must use becomes a reflection of him/herself and the pride which is attached to a job well done. At the carrier level, the condition of the equipment projects the

company image. For shippers and their customers, the equipment used becomes a signal of the service quality which they can expect to receive. Managers' ratings of the importance of equipment reflected these concerns. The condition of the equipment to be used was ranked of more importance, 77.4 percent very/extremely important, than the type of equipment, 62.9 percent very/extremely important. In the 1989 study, equipment condition was considered to be an important consideration by 78.4 percent of managers. This reflects the reality that if the equipment does not perform, the job is not completed, and the driver does not get paid. In this no-win situation, both the driver and the shipper are angry, and the carrier could lose both.

Carrier reputation. The final message component stressed by management concerns carrier reputation. Company reputation includes how a carrier is viewed by its external customers and competitors, and by its internal customers, the employees. Eighty-two percent of respondents indicated that company reputation was very/extremely important to drivers when considering the relative merits of a potential employer. This is higher than the 76.4 percent of managers who felt that it was an important consideration in the 1989 study.

Reputation is built on past performance, therefore a driver might use reputation to gain insight into how he/she is likely to be treated. Reputation also serves as an indicator of the carrier's prospects for continued economic viability. In today's highly competitive operating environment, those carriers who do not have a reputation for high reliability are the most likely to go out of business. In this circumstance, the driver would find him/herself looking for another position.

A second measure of carrier reputation in its relations with drivers, is management accessibility. Accessibility was considered to be very/extremely important by 54.9 percent of our respondents. Management's attitude toward the driver affects the efforts made by schedulers, dispatchers, and other personnel which have close contact with the driver. It can also affect the treatment that the driver receives at the shipper's dock. Driver's access to management in many cases is an indicator of the respect afforded the driver.

MANAGERIAL IMPLICATIONS

Driver turnover continues to be a problem that plagues carrier efforts to provide the progressively higher levels of service expected by shippers. In their effort solve the turnover problem, managers must answer three important questions. The first is; Does the character of your driver work force need to change? If the answer to this is yes, then the second question to be answered is; What characteristics define the successful driver in today's working environment? The final question is; What factors does this driver consider to be important in the selection of employer? Only after these questions are answered can a recruitment program to attract qualified drivers be designed.

Motor carriers have become specialty service providers who are concerned with much more than the simple delivery of goods. In this environment, the driver is the crucial link in the provision of those services. In order to efficiently and effectively perform the required duties, the driver must have

1. the technical expertise to operate communication, tracking, and other high tech equipment,
2. the human relations skills to maintain the one-on-one personal interchange that is the backbone of high touch service, and
3. the integrity to represent the carrier in the best manner possible.

In a recent study, drivers expressed feelings of pride concerning their role in providing customer satisfaction.[12] In other words, the driver needs to be a highly trained member of the team working to provide for the shipper's and the shipper's customers' service needs.

Providing consistent, high levels of specialized service requires a stable, well trained driver force. After preferred driver characteristics have been identified, managers must determine the factors drivers consider to be most important when choosing a future employer. In addition, those factors which motivate a driver to stay or conversely to leave an employer must be identified. This may be accomplished through such mechanisms as personal interviews of long-term drivers, exit interviews of those who leave, and focus groups of current drivers. It will probably be necessary to employ an outside agency to perform this research so that drivers are assured of anonymity. An additional benefit of the process may be the conveyance of management's concern for the driver and recognition of the driver's contribution to carrier success.

After identifying driver characteristics and the factors which determine their choice of employer, consideration must be given to the changes which might be required in the message and communication methods used to reach potential new hires. The message must be reviewed to see that those factors which drivers find important are included. The readership of available print media should be determined. It may be necessary to use untraditional print media, e.g. trade journals, to reach those drivers with the identified skill set.

Experienced drivers possessing the necessary technical skills and meeting the required driver safety standards consider themselves to be professionals. Recruiting efforts by current drivers promotes a professional to professional exchange of information. It has been shown that extrinsic job factors such as relationships with management and co-workers contribute to driver satisfaction.[13] Because current drivers may work with the newly recruited drivers, they are unlikely to encourage drivers who are unable to maintain the expected service standards.

The emphasis of this research has been on identifying industry practices vis a vis the use of media and message for the express purpose of recruiting drivers in the motor carrier industry. An important point to remember is that as managers develop recruiting strategies it may be necessary to look beyond current practices and include more innovative methods to achieve the desired results. These methods might include the use of recruiting agencies, job fairs, booths at festivals and fairs, training programs, etc. The relative success or failure of these and other innovative methods depends on the success in targeting the desired audience.

No individual method is likely to be sufficient to meet recruiting needs. However, a recruiting strategy which includes a well thought out mix of traditional and innovative methods for getting out the message has the most chance for success.

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APPENDIX
Media Usage Questions

The following questions refer to the use of advertising in your efforts to recruit qualified drivers. Please answer the questions as completely as possible. If you would like to make any additional comments, we would welcome your input.

1. Media Usage : **Please rank your usage of the following media used for driver recruitment according to the following five point scale, with a five meaning "used most frequently" and a one meaning "never used." Please circle the appropriate number.**

	Never Used				Used Most Frequently
Radio	1	2	3	4	5
TV - Local	1	2	3	4	5
TV - Cable	1	2	3	4	5
Local Newspapers	1	2	3	4	5
Other Newspapers	1	2	3	4	5
Trucking Trade Publications	1	2	3	4	5
General Magazines	1	2	3	4	5
Messages on Company Trailers	1	2	3	4	5
Notices at Truck Stops	1	2	3	4	5
Notices at Local Schools	1	2	3	4	5
Billboards	1	2	3	4	5
Recruitment by Current Drivers	1	2	3	4	5
Flyers/Handbills	1	2	3	4	5
Private Employment Agencies	1	2	3	4	5
State Employment Offices	1	2	3	4	5
Others (please list)					
a) _____	1	2	3	4	5
b) _____	1	2	3	4	5

2. Media Effectiveness: **Of the media mentioned in question one above, please rank them according to their usefulness in attracting *QUALIFIED AND HIREABLE* driver candidates.**

	Not Used	Least Effective				Most Effective
Radio	0	1	2	3	4	5
TV - Local	0	1	2	3	4	5
TV - Cable	0	1	2	3	4	5
Local Newspapers	0	1	2	3	4	5
Other Newspapers	0	1	2	3	4	5
Trucking Trade Publications	0	1	2	3	4	5
General Magazines	0	1	2	3	4	5
Messages on Company Trailers	0	1	2	3	4	5
Notices at Truck Stops	0	1	2	3	4	5
Notices at Local Schools	0	1	2	3	4	5
Billboards	0	1	2	3	4	5
Recruitment by Current Drivers	0	1	2	3	4	5
Flyers/Handbills	0	1	2	3	4	5
Private Employment Agencies	0	1	2	3	4	5
State Employment Offices	0	1	2	3	4	5
Others (please list)						
a) _____	0	1	2	3	4	5
b) _____	0	1	2	3	4	5

Continued . . .

Continuing APPENDIX
Media Usage Questions

3. Message(s) Used: **How would you rank the following message items in terms of your usage or emphasis in your driver recruiting efforts. A one means "not important" and a five means "extremely important."**

	Not Important				Extremely Important
Wages	1	2	3	4	5
Health Benefits	1	2	3	4	5
Pension Benefits	1	2	3	4	5
On-the-Road Expenses	1	2	3	4	5
Equipment Type	1	2	3	4	5
Equipment Condition	1	2	3	4	5
Company Reputation	1	2	3	4	5
Sick Leave	1	2	3	4	5
Vacation Time	1	2	3	4	5
Sign-up Bonus	1	2	3	4	5
Advancement Opportunities	1	2	3	4	5
Time **NOT** on the Road (Time Home)	1	2	3	4	5
Access to Upper Management	1	2	3	4	5
Freedom from Direct Supervision	1	2	3	4	5
Extra Training on Job	1	2	3	4	5
Other (please list)					
a) _____	1	2	3	4	5
b) _____	1	2	3	4	5

IMPACTS OF U.S. ENVIRONMENTAL CONTROLS UPON OCEAN TANKERS

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We live in a world that continues to be increasingly dependent upon petroleum. There are long distances between major petroleum sources and petroleum markets and large ocean-going vessels, known as tankers, carry this petroleum and its products. Tankers have increased in size and some are huge. Very Large Crude Carriers (VLCCs) weigh between 200,000 and 300,000 deadweight tons (dwt); ultra-large crude carriers (ULCCs) can reach 500,000 dwt. (ULCCs are about 50 times as large as World War II-era "T-2" tankers.) Mostert said that tankers: "Are the biggest ships that have ever been, their dimensions being one of the technological audacities of the century. . . . They were the harbingers of that new manifestation of global strategy and national self-interest, the energy crisis. . . ."[1] Petroleum tankers provide about one half of the carrying capacity of the world's merchant fleet.[2]

The phrase "economies of scale" certainly applies to large tankers. However, from an environmental protection standpoint, another applicable phrase is "carrying all of one's eggs in a single basket." If and when there is a spill incident involving a large tanker, the quantity of oil spilled is so great that it overwhelms whatever man-made or natural defenses there may be to protect the environment from damage.

In the United States, the public called for action following the grounding and spill of the Exxon Valdez in Alaska's Prince William Sound. Congress responded by passing the Oil Pollution Act of 1990 (OPA90).

Here is a summary of OPA90 as applied to the maritime industry. The law (1) required tankers in U.S. waters to have a Certificate of Financial Responsibility (COFR) with essentially unlimited liability; (2) required all new tankers be built with double-hulls, accompanied by a size and age phase-out of existing tankers beginning in 1995 and ending in 2010; (3) mandated that the Coast Guard tie into the National Driver Register to detect drunk driving convictions; (4) increased Coast Guard authority to deny or revoke licenses and merchant mariners' documents; (5) authorized the removal of incompetent masters; (6) increased the Coast Guard's authority to deny entry to the United States of those foreign vessels with deficient manning standards; (7) limited work hours on tankers to 15 hours per day, but no more than 36 in any 72 hour period; and, (8) required the Coast Guard to designate areas where two licensed personnel are required to navigate a vessel, as well as where tug escorts are necessary.[3]

The two requirements upon which this paper shall focus are the Certificates of Financial Responsibility, and double-hulls for tankers.

CERTIFICATES OF FINANCIAL RESPONSIBILITY (COFR)

The COFR requirement for unlimited liability caused great concern within the tanker insurance industry, which consists of Protection and Indemnity (P&I) Clubs. These P&I Clubs were very reluctant to issue policy coverage when unlimited liability in involved. Previously, the responsible party was the ship owner and/or the cargo owner; the P&I Club protected them. OPA90 allows litigants to directly pursue the insurance company making all its assets vulnerable. Those traditional P&I Clubs initially refused to write coverage since it would expose them to direct lawsuits for unlimited liability.

The consensus was that only large companies like the major oil corporations will have adequate financial resources to comfortably acquire COFRs; "Few small tanker owners have been able to obtain their certificates of financial responsibility, but large tanker owners with substantial financial resources continue to find ways to certify their fleets."[4] Recently, a handful of new companies have come into being hoping to make policies available that will meet the COFR requirements. INTERTANKO (the International Association of Independent Tanker Owners) feels that: "No satisfactory solution to the question of Certificates of Financial Responsibility is available for the majority of tanker owners wanting to trade to the United States."[5] The deadline for COFR coverage was December 28, 1994. In 1996 it was reported that all tankers operating in U.S. waters had met the COFR requirement, with 62 percent relying on insurance companies, 37 percent self-insuring or having bank guarantees, and one percent buying surety bonds.[6]

Ship brokers predicted that tankers backed by a COFR soon will command a premium in the charter markets. The COFR requirement has already impacted the U.S. oil trade with several small tanker firms withdrawing from the U.S. market. Bishop thinks that COFRs will add an additional 2-5 cents/barrel to the cost of tankering and he added that U.S. refineries will continue to have trouble with increased air quality regulations which will foster even more changes in tanker market logistics.[7]

Another concern to tanker owners, recently come to the fore, is the proposed regulations for Natural Resources Damage Assessment (NRDA) as provided for under oil pollution laws passed in 1990. In their present form, the proposed regulations can add up to almost unlimited liability for tanker operators based on theoretical models. Because of the speculative nature of these projections, some protection and indemnity clubs may deny coverage for NRDA-related claims. Should that happen, tanker owners would be faced with a dilemma that could interrupt the flow of oil to the U. S. Computer models for assessing damage have been criticized. "In one case, a spill of 10 gallons of heavy crude oil led to a computer-generated assessment of $1.28 million, or $128,000 . . . per gallon spilled. The result assumed a mortality of 400,000 birds per barrel spilled. . . . In fact, the Exxon Valdez caused a mortality of approximately two birds per barrel."[8]

The International Association of Classification Societies (IACS) and its Enhanced Survey Program (ESP) is attempting to root out sub-standard tonnage in the tanker industry. This program comes largely as a result of an increase in tanker losses at the turn of the decade and the negative publicity directed against the IACS and its members as a result. The societies have been criticized for not being tough enough on ship owners and allowing a large number of unsafe vessels to continue in operation. Some companies are utilizing in-house vetting programs to assure quality tonnage for their business. Recently, the three largest IACS members published their own ideas for marine safety. Without consulting other members, the American Bureau of Shipping, Det Norske Veritas, and Lloyd's Register launched a plan "to strengthen their transfer rules so that no ship can switch from one

to another until all outstanding repair requirements have been completed."[9]

Flag State Control, where the vessel's country of registry acts as enforcing agent, has been the method for safety and environmental control to date. Enforcement, however, has been less that aggressive in many cases.

"Port State Control" is the new buzzword whereby the regulatory agency of the vessel's current port acts to enforce flag state regulations and, as a minimum, the regulations of the port state. "Members of the Paris Memorandum of Understanding on Port State Control (MOU), which have a voluntary agreement to check the condition of a quarter of foreign-flag ships calling at their national ports each year, currently focus their inspections toward passenger ships, bulk carriers, and vessels registered in countries with a poor maritime safety record."[10] This method has proven to be much more pro-active.

The U.S. is not signatory to the Paris MOU but the U.S. Coast Guard has been asked to implement a Port State Control system for the U.S. This system was initiated in 1994 and the Coast Guard is acting to implement and improve the system. The initial system had concentrated on vessel owners, operators, and flag states. Under the newer system, the Coast Guard's data base will include the performance of vessel classification societies, since these societies presumably both review plans for vessel design and rebuilding, and inspect vessels to ensure compliance with safety standards. The Coast Guard utilizes United Nations International Maritime Organization (IMO) guidelines to evaluate the work of classification societies, and the quality of work of the different classification societies varies. This information, along with records concerning the vessel's owner, vessel history, cargo carried, and vessel age are entered into a matrix where scores are assigned. The scores determine a "Boarding Priority," meaning which vessels will be selected for inspection, should they enter U.S. waters.

DOUBLE-HULL TANKER CONSTRUCTION

Double-hull construction is when a second layer of metal separates the cargo tanks from the ocean; the space between the two layers being occupied by air when the cargo tanks are carrying oil, or water when in ballast (while cargo tanks are empty). As might be expected, double-hull construction takes more capital than single-hull due to increased design, material and labor requirements. Estimates for the increase in construction costs vary and can run as high as 20 percent over a single-hulled vessel.[11] In addition to construction costs, operating costs for double-hulls are also higher. Tank inspection and maintenance will just about double and the increased effort resulting from double-hull construction has been estimated as high as 25 percent. For a small tanker spending 2 million dollars a year for inspection and maintenance, an additional $500,000 is necessary.

No new U.S.-flag double-hull vessels have been delivered since OPA90 although some are under construction and some existed previously; as examples, Marine Transport Lines operates the double-hulled Chemical Pioneer and Chevron Shipping operates a five-vessel class with double-hulls. On May 17, 1996, Avondale Shipyards in New Orleans launched the first of four double-hulled tankers that were designed and constructed to comply with the double-hull requirements of OPA90.

The spill prevention theory behind double-hull construction is that upon grounding or collision, there is a void space to absorb the impact without allowing oil to escape. Any ruptured tanks are flooded with sea water and the ship rides deeper in the water. The risks associated with double-hull construction are centered around major hull breaches and explosions.

The very spill which fomented OPA90, the Exxon Valdez, is believed to have been less due to single-hull construction. If the vessel had been double-hulled, the majority of the ballast tanks would have been flooded and the increased weight would likely have exceeded

the vessel's inherent strength; the ship would have broken up and instead of 260,000 bbls, the spill could have been the entire cargo of approximately 1,000,000 bbls. The primary concern within the industry with a major casualty is that many ballast tanks will be ruptured and the vessel will break apart, and one study "concluded that double bottom design is a detriment to a grounded vessel salvageability and therefore increases the chances of a major spill. Double bottoms may prevent minor pollution in vessel groundings, but probably increase the risk of major pollution in large vessel incidents."[12]

Another risk is the control of ballast tank atmosphere. Cargo tank vapor space (the space between the surface of the liquid and the top of the tank) is filled with inert gas to prevent any possibility of explosion. Ballast tanks are not inerted because they normally carry only water. The risk is when cargo enters the ballast tank and the vapor mixes with the air and forms an explosive mixture. The cargo may gain entry due to corrosion or cracks and if not detected, will endanger personnel attempting entry. Crew members may be overcome by the vapor or suffocate due to lack of oxygen, or an explosion may occur. Inerting ballast tanks adds significantly to construction costs. A final consideration relative to double-hull construction is the use of high tensile steel. This material allows the designer to meet the necessary construction and safety requirements with less metal. High tensile steel, however, corrodes at the same rate as "normal" steel and fatigue life is diminished. Using high tensile steel, as is becoming the norm, will require exceptional vigilance insofar as inspection and testing for rust, corrosion, and inherent material strength.

A separate issue with ballast is ballast water pollution. Ships use ballast water to maintain their sea-worthiness; the various "bending" or "shear" forces felt by the vessel's hull are brought to within design and safety limits by adding ballast weight at desired points within the hull. In the case of tankers, this weight is added for the empty leg of the voyage. Nearly all ocean-going vessels are built with the capability for carrying ballast water, and this is taken on from the water wherever the vessel is floating, whether inside a harbor or at sea. When no longer needed, the water is pumped overboard, again wherever the vessel happens to be.

By using tanks designated for ballast water only, oil pollution is avoided. However, a new environmental problem arises and that is the transfer of marine life to an area where it may not be desired. There is some awareness of this issue. Chevron double-hull tankers, going from San Francisco Bay to the Gaviota Terminal near Santa Barbara, take on ballast in San Francisco Bay. Shortly after leaving the Bay, they discharge this ballast water and take on ocean water. This step minimizes the possible bad effects the San Francisco Bay water might cause.

Alternative designs, potentially equivalent to double-hull, have not yet been acted on by the Coast Guard. Among these are the mid-deck tanker design (and two variations: the Coloumbi egg design, the POLMIS design) and the American Underpressure System. (The mid-deck tanker design has an additional deck installed approximately half way between the keel and the main deck, and below the loaded water line. Should a grounding or collision occur causing damage to the lower tanks, higher water pressure from outside the vessel will keep the oil in the tank. The American Underpressure System acts to create a partial vacuum in the vapor space above the cargo. By establishing and maintaining this vacuum after an incident, cargo is held inside the ship.) The Coast Guard is studying these designs.

The major advantage to double-hull construction is that the ballast tanks act to absorb the impact without allowing oil to escape. Almost everyone, industry and environmental alike, agree that this design will reduce the amount of oil spilled in minor situations involving limited hull breech. All of these scenarios have occurred and double-hull construction has prevented a spill.

Current thinking is that the double-hull requirement will not spread to other countries. Vessels delivering oil from other countries to the U.S. will bring it to within about 100 miles of the U.S. shore in single-hull tankers. At that point out at sea it will be lightered (transferred at sea) to double-hull tankers that will deliver it to U.S. ports. In mid-1995, the U.S. Coast Guard was establishing areas for lightering in the Gulf of Mexico, "The Coast Guard said the zones are necessary because the tanker industry is not building double-hulled tankers fast enough . . . ."[13]

U.S.-FLAG TANKERS

The Jones Act requires that cargo going from one U.S. port to another be carried on a U.S.-flag vessel. Under this act, many U.S.-flag tankers carry clean products (jet fuel, gasoline, diesel fuel, etc.) since crude oil is brought in on less expensive foreign flag vessels. (Currently, all Alaskan North Slope Crude Oil is brought to the U.S. on U.S.-flag tankers.) As more and more of the U.S.-flag tanker fleet is phased out under OPA90, freight rates for the remaining few will increase. Shipping companies will be reluctant to build new ships or convert old ones due to higher operating and construction costs for U.S. ships.

"It's also thought that U.S. environmental regulations may force the Maritime Administration to grant exemptions to the Jones Act, giving business to foreign tanker owners."[14] Representing the current change in the U.S. tanker market, this quote shows growing fear that while the fleet of tankers worldwide will continue to grow, the U.S.-flag tanker fleet will be reduced. A National Maritime Administration study indicated that sufficient Jones Act vessels would be available for 1995, but "shortages of product tankers and tank barges could develop in 1996."[15]

There will be increased controversy over subsidies to U.S.-flag ship owners. An example: "A $139 million federal loan guarantee to a U.S.-flag tanker company modernizing four aging vessels in a Louisiana shipyard is angering competitors and has reopened a debate over the Maritime Administration's program of extending financial support for the shipbuilding industry."[16]

There will also be continuing controversy over the amount of regulation being imposed on the shipping industry. Individual coastal states are also getting into the act by enacting their own specific regulations since the Exxon Valdez incident. The U.S. Coast Guard had to inform Washington State that some of that state's proposed regulations were in topical areas where the Coast Guard claimed jurisdiction. California's Office of Oil Spill Prevention and Response is requiring "escort" tugs to accompany single-hull oil tankers in San Francisco Bay. Each escorting tug costs an estimated $5,000. In June, 1995, Massachusetts environmental officials delayed implementation of a "clean air" rule requiring vapor recovery equipment on tankers. The rule would have applied to the Chelsea River, where Coast Guard requirements meant that tankers that had just discharged their cargo would have to take on ballast before moving down river. The taking on of ballast would have released vapors.[18] These are only examples of state actions, but they show that tanker operators have many new rules to read and to follow.

WORLDWIDE CONCERNS

After having looked at two specific new U.S. requirements, we can step back and try to see a bigger picture of where they fit in a global setting of what is truly a global industry. Worldwide demand for energy continues to grow. The world's energy demand increased 6.7 percent between 1987 and 1992—a little over one percent per year). Growth rates are expected to return to about 1.5 percent to 1.7 percent per year for the rest of the decade due to the ending of the world-wide recession, the end of the demand slump in the former USSR countries, and continued rapid growth of emerging nations in South East Asia, Latin America and the People's Republic of China. Oil is about 40 percent of energy demand (natural gas is about 23 percent). "The world's major industrial consumers of energy are still structurally bound to depend primarily on oil and oil products as fuel

sources, and the transfer to gas-fired boilers or 'clean' sources of electricity will necessarily occur only gradually."[17]

Worldwide, the major sources of petroleum are the Middle East and North Sea. They supply oil to the U.S., as does Venezuela. Another source of U.S. oil is the Alaskan North Slope, with oil moving from Valdez by tanker to U.S. ports on the either West Coast or East Coast (via a pipeline parallel to the Panama Canal).

Air pollution controls have impacted upon the refining industry. Historically crude has been transported to the end user markets due to refinery location, and refineries were built near major population centers to take advantage of skilled labor and technology. This scenario has been changing with producing countries building complete refineries near active fields. Burrill feels that the recent increase in regulation regarding air and water quality in the developed nations will tend to drive refineries to other countries. Major oil companies will build elsewhere and will essentially be "exporting air pollution"[18] in order to remain competitive. A second reason for this is that the oil-exporting nations wanted to create more jobs in their own economies. "Turn key" contracts have resulted in operating refineries in the Middle East and West Africa allowing these countries to pursue the export of refined products and to take advantage of the higher profit margin. Tankers that carry petroleum products are smaller than those that carry crude oil. Product buyers do not buy such large product cargoes and most ports do not have the capacity to handle large ships discharging products, or to store the refined material. The ramifications of environmental protection regulations can be complex since refined products are considered more hazardous than crude. For example, reformulated gasoline, blended with regular gasoline to reduce carbon monoxide produced by autos, is much more dangerous for tankers to carry. The reason is that some of its contents render ineffective the foam traditionally used to combat tanker shipboard fires.

Future oil production acts as a guideline for changes in tanker demand. The consensus appears to be that tanker tonnage will rise from approximately 207 million deadweight tons (dwt) to around 240 million dwt by 2000 (a 16 percent increase). Most of the increase will be for long haul transits in 90,000 dwt vessels and up. Between 1996 and 2000, a 24 percent increase in crude tankering is expected, mainly in the long haul routes.[19]

Drewry Shipping Consultants forecast an average annual growth of two percent in tanker demand for the period 1994 to 2000.[20] Long haul crude transport is expected to grow, with the emphasis on VLCCs. The growing South East Asia market, however, will demand larger amounts of product as economic development progresses.

Worldwide controls on the tanker industry come from the International Maritime Organization (IMO), which is an agency of the United Nations. Their initial thrust was safety at sea, but they now are concerned with pollution prevention as well. They also direct programs of international cooperation to deal with oil spills, wherever they occur. IMO cites figures that major oil spills have declined since 1980 and, in addition, less oil enters the water because of stricter maritime operational practices (such as tank cleaning) and equipment (segregated ballast tanks).[21] Tanker firms and other members of the petroleum industry also support and participate in "response teams" that will go anywhere in the world to help combat an oil spill and reduce its damage. Firms operating in the U.S. must also have government-approved "spill-response" plans that include contractual commitments stating what equipment and personnel they can make available to combat a spill. The result has been that competitors agree to help each other in case of a spill by providing personnel and equipment, such as "skimmers," to be shared.[22] Ship salvagers at the site of tanker accidents now have special training and equipment to reduce the leakage of oil from damaged hulls.

INDUSTRY RESPONSE

In light of the Exxon Valdez 1989 grounding in Prince William Sound, U.S. regulations regarding crew size, crew rest, ship construction, oil spills, and spill response have grown. The new U.S. and state restrictions are sufficiently severe that some companies (Shell and BP) are not allowing their vessels to trade in U.S. waters. Others are considering similar action and some are distancing themselves from tankers altogether. Exxon has renamed its shipping company "SeaRiver" apparently in an attempt to remove the Exxon name from tankers; a far cry from the days when oil companies painted their name in large block letters along the mid-section of the hull. Major oil corporations will look to reducing liability by avoiding in-house shipping operations; they will be outsourcing their transportation business. Those remaining companies are increasing their efforts to assure quality ships are being used. Chevron, Exxon and others have a "vetting" process whereby each vessel to be used for their cargo or at their terminals is approved as being suitable. Vetting includes vessel trading history, comparing vessel size and mooring equipment to berth size and configuration, water depth limits versus vessel draft, safety equipment and general vessel condition. This emphasis on quality should result in an increasing premium being paid for modern tanker tonnage.

However, Clarkson Research Studies Limited feels "the oil industry will continue to rely on using low grade tankers for the foreseeable future."[23] Also, "Some of the world's most safety-conscious oil companies with comprehensive ship-vetting procedures regularly charter elderly tankers."[24] Clarkson envisions the continuation of a two tier system, at least in the VLCC market segment. "The trading pattern of high productivity vessels was skewed toward the OECD countries. In particular the quality of ships visiting North America was above average, suggesting that OPA90 is having the desired effect. Low productivity vessels are more prominent in the non-OECD countries."[25]

Captain Dennis Bryant, deputy director of the Coast Guard's staff that is writing pollution act rules has said "Our analysis indicates there will be a tanker shortage . . . . We don't see construction rates (of double-hull tankers) as adequate to meet the coming shortage."[26]

CONCLUSIONS

At the beginning of this paper was discussion of two specific new U.S. controls on the tanker industry mandated by OPA90: the double-hull tankers, and for almost unlimited liability protection. These are just two requirements from a long list.

There is disagreement as to the effectiveness of a tanker's double-hull. Unfortunately, we may have to wait for an incident to determine how well they work. Possibly the next wreck will indicate some of the currently-mandated design's shortcomings, and advisory circulars will be issued by a federal agency indicating what additional safeguards must be either retrofitted to existing vessels or included in new ones.

The insurance requirement may be of some help, although at a cost. Older vessels will avoid U.S. ports, and this in itself may help protect the nation's shores, since older vessels are sometimes fatigued.

These requirements can be viewed in a worldwide perspective of the petroleum industry, and in a growing demand for environmental protection. One can ponder the extent to which national regulations reduce pollution or merely shift its incidence.

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AN EXAMINATION OF INTERNATIONAL LOGISTICS PRACTICES OF U.S. LOGISTICS PROFESSIONALS

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Over the last two decades, the growing interdependence of the world economy and the subsequent increase in foreign trade volume have contributed to the considerable expansion of global logistics activities. As global logistics operations became almost a daily routine for many logistics professionals, they have begun to search for adaptive logistics strategies to improve global competitiveness. To assist U.S. logistics professionals in fostering such strategies, this study empirically examines how the globalization of business has influenced the way U.S. logistics professionals adapt themselves to a dynamic international environment fraught with countless risks and complexities.

The world of the late 20th century is often characterized by the globalization of business activities. In the present era of globalization, multinational firms (MNFs) must re-formulate and re-orient their strategies to cope with the dynamics of a changing global environment. Otherwise, they may suffer from unexpected barriers or impasses stemming from differences in culture, business custom, language, tastes and preferences, laws, and ethics. These barriers may include unnecessary distribution bottlenecks at the importing/exporting ports, unwanted shipping damages during international transit, unacceptable delays at the customs office, and unprovoked miscommunication among shippers, carriers, and third-party logisticians.

To obviate these barriers, logistics professionals should develop innovative, flexible logistics strategies which help them adapt to the changing international environment and to respond effectively to their foreign customers' needs. Without formulating such strategies, they cannot gain the full benefits of international logistics. As such, the objectives of this study are to assist logistics professionals with the identification of the main issues of international logistics and the formulation of effective international logistics strategies for their MNFs. First, the study investigates specific international logistics practices of firms engaged in international trade. Second, it explores the key factors affecting the movement of goods in international trade. To accomplish the study objectives, the authors have researched the prevalent practices of 63 MNFs located in the United States.

STUDY METHODOLOGY

A special questionnaire was developed to determine the ways U.S. logistics professionals have dealt with international distribution operations. The questionnaire (see Appendix) addresses the respondents' company profile, international shipping practices, international modal choice, international freight term negotiation process, overriding factors in international port selection and packaging, and important barriers to overcome in international logistics.

The questionnaire was mailed in April 1994 to approximately 800 U.S. logistics professionals randomly selected from the recent membership directory

of the Council of Logistics Management (CLM). Since we did not know ahead of time which respondents were genuinely involved in global trade, only those whose firms were actively engaged in international logistics were asked to respond. From this group, 63 responded. Although this response rate (7.9%) is relatively low, the low survey response rate is not unusual in the empirical studies[1] dealing with international logistics/sourcing issues. Another reason for a low response rate may be a lack of willingness of CLM members to respond to the high number of mail surveys that they receive each year. To extract more meaningful statistical information from this small sample, a test for non-response bias involving comparisons of "early" (e.g., responses received within three weeks of the initial mailing) and "late" respondents in terms of item responses could have been performed. However, only a very small number of late responses that we received precluded such a test. Thus, some caution should be exercised in generalizing our survey results due to a potential non-response bias.

Represented in our sample are many types and sizes of multinational firms. As expected, a majority (61.9%) of the responding firms are in the manufacturing sector (33.3% in consumer goods and 28.6% in industrial goods). Other major sectors include transportation and warehousing (12.7%), wholesale and retail trade (7.9%), and wholesale trade (7.9%). The remaining sectors are retail trade (4.8%) and other service sectors. Most of the sample firms (93.7%) had more than 100 employees; 72 percent had more than 500 employees. Ninety-five percent of the responding firms employed more than three logistics professionals. Thirty-five percent employed 5 to 20 logistics professionals, 7 percent had between 20 and 50 logistics professionals, and 46 percent employed fifty or more. Annual sales volumes of the most sample firms (95.2%) ranged from $ 20 million to over $ 1 billion. The majority were in the $ 100 million to over $ 1 billion range (74.2%). Finally, about three-fourths of the responding firms (75.4%) indicated that at least 5 percent of their firm's 1993 total sales was overseas.

These descriptive statistics indicate it is likely that most firms involved in international logistics will be large manufacturing firms, although the sample was represented by others including service sectors. This characterization is partially due to the fact that less expensive and perhaps better quality manufacturing parts and materials are often available from overseas sources; consequently, logisticians from these manufacturing firms are more likely to engage in shipping these parts and materials from overseas counterparts. As a result, the sample characteristics may disproportionately reflect the practices of large manufacturing firms and may not be completely generalizable to other industry groups. Nevertheless, a series of t-tests were performed to examine whether the international logistics activities of small firms are different from that of their large counterparts. A series of *t*-tests show that mean responses of the two groups are almost identical with the exception of modal and port selection practices: (1) small firms in our sample are less concerned about geographic coverage of transportation mode in selecting the mode than are the large firms and (2) small and large firm respondents did not agree on the perceived importance of inland modal transfer in choosing the international port. To obtain other statistical information from this sample, the authors coded and analyzed all the survey data using the Statistical Package for Social Scientists.[2]

INTERNATIONAL SHIPPING PRACTICES AND MODAL SELECTION

Generally speaking, international shipping requires more handling and transfers than domestic shipping as the cargoes pass through ports, bonded warehouses, free trade zones, and customs offices. It also usually entails lengthy transit distances which require better protection of cargoes. To investigate how these inherent characteristics change the ways in which an international transportation mode is selected, we asked respondents which determinants are most critical to

transportation modal selection in a global setting and how the importance of such determinants affects international freight term negotiation. Respondents identified transportation cost, average transit time, and transit time variability as the three most important attributes. Thus there appears to be no dramatic difference in the modal selection decision between domestic and international shipments.[3]

Bender[4] noted that international transportation cost generally represents a much higher fraction of merchandise value than is the case in domestic transportation owing to longer distances involved and frequent modal transfers. Consequently, tight control of transportation cost is crucial for competitively serving world-wide markets because high transportation cost may negate other potential cost savings (e.g., cheaper labor or material cost) available through international trade. On the other hand, survey respondents identified speed as the second most important element affecting the modal selection decision, because a slow mode prolongs already lengthy cross-border movement, thereby increasing in-transit inventory carrying cost and the risk of cargo damage during the transit. Although transportation cost and speed are two primary concerns, respondents reported that consistent delivery service is also crucial for international modal selection, especially with the growing adaption of Just-In-Time (JIT) logistics principles.

TABLE 1
Determinants for
International Transportation Modal Selection

Factors	Degree of Importance, on Average		Rank
Transportation cost	1.690	(0.654)	1
Average transit time	1.702	(0.706)	2
Transit time variability	2.036	(0.860)	3
Convenient schedules	2.107	(0.824)	4
Geographic coverage	2.125	(1.010)	5
Shipment size	2.161	(1.092)	6
Cargo damage risk	2.589	(1.005)	7
Type of cargo being shipped	2.839	(1.092)	8
Insurance coverage	3.089	(1.032)	9
Types of cargo packages	3.089	(1.049)	10

Note: Numbers in parentheses represent standard deviations.

Scale for the Degree of Importance
1 = Extremely important
2 = Somewhat important
3 = Neither important nor unimportant
4 = Somewhat unimportant
5 = Not at all important

Also, this finding is consistent with the result suggesting that the two most important factors affecting international freight term negotiation are on-time delivery and freight rate (see Table 2). In other words, international freight term negotiation often focuses on the assurance that cargoes will arrive on time at the right cost.

In addition to the selection of international transportation mode, international shipment is accompanied by many complex tasks such as overwhelming paperwork requirements, various customs procedures, and foreign government restrictions. To effectively handle such complex tasks, a large number of firms often utilize the services of foreign intermediaries and import/export specialists.

With this in mind, respondents were asked to indicate who primarily assumes international cargo booking responsibility. Similar to the most recent survey result on the use of third-party logistics services,[5] a majority (71.9 %) of the respondents said they frequently use the services of third-party logisticians including foreign freight forwarders, brokers, non-vessel owning common carriers (NOVCCs), and shippers associations. As shown in Table 3, the most commonly used third party logistician turned out to be a foreign freight forwarder. This finding coincides with earlier reports that nearly every international company utilized the service of a foreign freight forwarder.[6] The popularity of freight forwarders may be due to the fact that they can provide a variety of export shipping services such as necessary vessel-space booking, shipment consolidation, export documentation, legal counselling, and export packaging.[7]

TABLE 2
Determinants for
International Freight Term Negotiation

Agenda	Degree of Importance, on Average		Rank
On-time delivery	1.309	(0.540)	1
Freight rate	1.482	(0.660)	2
Mode of transportation	1.964	(0.744)	3
Shipment tracing	2.073	(0.813)	4
Containerization	2.127	(0.944)	5
Rate revisions	2.473	(0.813)	6
Damage claims liability and handling	2.500	(0.986)	7
Insurance coverage	2.945	(1.044)	8

Note: Numbers in parentheses represent standard deviations.

Scale for the Degree of Importance
1 = Extremely important
2 = Somewhat important
3 = Neither important nor unimportant
4 = Somewhat unimportant
5 = Not at all important

TABLE 3

International Cargo Booking Responsibility

Responsible Party	Percentage of Respondents	Rank
Foreign freight forwarder	28.9%	1
Shippers themselves	28.1%	2
Broker	22.3%	3
Non-vessel owning common carriers	16.5%	4
Shippers association	4.1%	5

Typical Forms of International Intermodal Services

Form	Percentage of Respondents	Rank
Landbridge	50.7%	1
Minibridge	31.3%	2
Microbridge	17.9%	3

In an effort to shorten transit time, any logistics managers involved in international shipping also consider substituting intermodal routes for all-water routes. For example, with the emergence of point-to-point freight rate quotes, the landbridge alternatives across Canada, U.S. and Mexico can bypass the Panama Canal and subsequently prevent delays and tolls imposed by the Panama Canal. Considering such convenience of a landbridge, the popularity of this alternative among the respondents is understandable.

OBSTACLES TO INTERNATIONAL LOGISTICS

While international logistics activities can offer a variety of opportunities, they also can pose a number of problems stemming from additional documentation requirements, foreign government regulations, trade/non-trade barriers, lengthy geographical distances, cultural differences and so forth. To identify the significance of such problems, respondents were asked to rate the seriousness of potential logistical problems involving export/import transportation on a Likert scale ranging from 1 (very serious) to 5 (no problem at all). The results, which are summarized in Table 4, indicate that the most serious obstacle to effective international logistics is documentation requirements. As a matter of fact, Davies[8] noted that, compared with domestic logistics, international logistics generally requires higher amounts of data for complete documentation, and subsequently, documentation cost is much higher. For example, the average cost of processing a single set of documents for a cross-border shipment of goods in 1982 was estimated to be $395.[9] Additionally, despite the continued effort to simplify documentation requirements, the number of documents ranging from 10 to over 100 are usually required for an export shipment.[10] To further alleviate documentation problems, for example, 18% of the top 100 British firms have recently installed the software called "Exportmaster" that aimed to integrate and automate the necessary documentation procedures involving the entire export transaction cycle.[11]

Other serious problems include miscommunication, lengthy transit times, foreign government's regulations, and customs barriers. Despite great advances in today's communication technology, respondents reported serious difficulty in communicating with foreign trade partners because of differences in languages, business customs, communication devices, and time zones. Lengthy transit times created by distant cross-border movement extend lead times, thereby either reducing customer

TABLE 4
Major Obstacles to Effective International Logistics

Variable	Degree of Seriousness, on Average		Rank
Documentation requirements	1.814	(0.973)	1
Miscommunication	2.052	(0.981)	2
Lengthy transit times	2.096	(0.864)	3
Foreign government's regulation	2.123	(1.001)	4
Customs barriers	2.241	(0.885)	5
Loading/unloading delays at foreign ports	2.684	(1.003)	6
EDI incompatibility	2.729	(1.064)	7
Damage claim disputes	2.741	(0.134)	8
Cultural differences	2.793	(1.120)	9
Modal incompatibility	2.911	(1.049)	10
Difficulty in freight rate negotiations	3.000	(0.955)	11
Global outsourcing	3.071	(0.988)	12
Cargo insurance arrangements	3.246	(0.912)	13

Note: Numbers in parentheses represent standard deviations of scales.

Scale for the Degree of Seriousness
1 = Very serious
2 = Somewhat serious
3 = Neither serious nor trivial
4 = Somewhat trivial
5 = No problem at all

responsiveness or increasing in-transit inventory carrying costs. Government regulations of other nations can also pose serious logistical problems, because such regulations often restrict the free flow of certain commodities. For instance, the Central Planning Commission and the National Ministry of Commerce in China used to limit the distribution of tightly-controlled goods such as cotton garments, petroleum, and cooking oils to other countries.[12] Although the wider acceptance of the General Agreement on Trade and Tariffs (GATT) may have alleviated customs barriers, the respondents still listed customs barriers as a somewhat serious obstacle. The rationale may be that customs procedures require time-consuming and expensive inspection of imported goods at the time of their entry which, in turn, can delay local shipment of imported goods.

INTERNATIONAL PORT SELECTION

Since selecting the wrong importing/exporting port can add extra time, risk, and expense to a global shipment's overall cost, port selection is one of the most important decisions in the international logistics arena.[13] In particular, ports play a critical role in the success of international intermodal shipments, because they represent a convergence of intermodal interests.[14] Table 5 shows the results of our survey on the factors affecting shippers' selection and evaluation of international port facilities. The respondents indicate that easy access to inland modal transfer is most important for selecting international ports. Since many ports serve as interchange points for international intermodal transfers, the ports should provide easy access for inland transportation modes such as barges, steamships, motor carriers, and rails. Otherwise, intermodal exchange delays and interruptions at the

TABLE 5
Key Factors that Affect International Port Selection

Factors	Degree of Importance, on Average		Rank
Easy access to inland modal transfer	1.889	(0.833)	1
Convenient pickup/delivery schedules	1.927	(0.920)	2
Faster loading/unloading services	2.145	(0.911)	3
Low freight handling charges	2.218	(0.994)	4
Cargo damage/loss protection	2.611	(1.036)	5
Special equipment availability	3.056	(1.265)	6
Facilities for large/odd-sized freight	3.685	(1.043)	7

Note: Numbers in parentheses represent standard deviations of scales.

Scale for the Degree of Importance
1 = Extremely important
2 = Somewhat important
3 = Neither important nor unimportant
4 = Somewhat unimportant
5 = Not at all important

ports can further increase transit times and cargo handling costs. As a matter of fact, Talley[15] observed that a good choice of the port could lower logistics costs incurred by shipping lines and inland carriers in ports. Nevertheless, most U.S. ports still are not well-equipped to provide rapid sea-surface or air-surface transfers. In particular, most U.S. ports were reported lacking direct vessel-rail transfer facilities, because rail yards were often located outside the port areas and subsequently rail lines cannot get right-of-way into the ports.[16] More recently, however, under the Intermodal Surface Transportation Act (ISTEA), some U.S. ports such as the Port of Oakland and some railroads such as the Southern Pacific Railroad and the Union Pacific Railroad have paved the way for the construction of Joint Intermodal Terminals which would lead the railroad to gain near-dock access to the port.[17]

Other factors perceived to be important are the convenience of pickup/delivery schedules and the speed of loading/unloading services, both of which greatly affect overall door-to-door transit times. Factors such as low freight handling charges and cargo damage/loss protection also received attention from the respondents due to their impact on the overall international logistics cost. On the other hand, the least important port selection factors include special equipment availability and facilities for large/odd-sized freight. That is to say, congruent with Murphy and Daley's study,[18] our respondents were less concerned about the provision of mere physical amenities in selecting the proper international port. This result, however, is contradictory to the similar study conducted earlier by Murphy et al.[19] indicating that equipment availability was most important in port selection.

DETERMINANTS OF INTERNATIONAL PACKAGING

In contrast with domestic shipping, international shipping often poses greater risks of cargo damage. The potential causes of such risks include frequent weather changes, rough rides during long overseas transit, mishandling during frequent cargo transfers, and customs inspection for contraband. To make matters worse, the resolution of disputes over cargo damage may not be easily found. This is especially

true when the two parties involved in the damage arbitration are of different nationalities and consequently are operating under different national laws and jurisdiction.[20] Our current survey also indicates that cargo damage claim disputes are one of the important hurdles for international logistics (see Table 4). Considering the seriousness of cargo damage risk in international shipping, a key to successful international shipping is to develop effective packaging strategies that may prevent or alleviate the potential risk of cargo damage and pilferage. Furthermore, the degree/type of packaging affects the transportation modal choice and the effectiveness of cargo handling. For example, light-weight packaging is ideal for containerized shipments, whilst odd-shaped packages require additional handling arrangements and the subsequent freight surcharge.

With this in mind, each respondent was asked to rate the importance of attributes that may lead to effective international packaging on a Likert scale ranging from 1 (extremely important) to 5 (not at all important). The mean responses along with their standard deviations are presented in Table 6.

As Table 6 shows, the respondents replied that the four most important attributes are resiliency (prevention of handling damage), dimensions for the best use of space, weather protection, and package material cost. Our findings indicating the importance of resiliency to distribution packaging is consistent with two earlier reports on packaging design.[21] Perhaps the importance of handling damage protection stems from both the shipper's and the carrier's concern that international shipments may be mishandled in break-bulk operations at inland modal exchange points, even if they are containerized. Dimensions for the best use of space can be the important packaging issue in a global setting, because cube utilization through reduced package size can help reduce overall logistics cost including transportation cost, handling cost, and storage cost. Considering that international consignments can be easily exposed to excessive heat and moisture resulting from sudden climate changes during the cross-continental movement, the importance of weather protection to international packaging is understandable. Package material cost also can be a concern of international shippers due to its contribution to overall logistics cost. This is why more flexible but less expensive film-based packaging is gaining popularity among international shippers.

On the other hand, it is interesting to note that international shippers still show a lack of concern over the environmental friendliness of packaging, despite the fact that an increasing number of foreign countries such as Canada, Germany, Denmark, and Japan enacted tougher legislation to reduce packaging waste.[22] However, as the Green Movement in Western Europe and Japan has become reality, the international logistics community will soon recognize the seriousness of packaging to environmental protection.

FINDINGS AND IMPLICATIONS

With the growing interdependence of nations and their economies, global logistics has become a necessity, requiring more adaptable logistics strategies that can deal with far more complex documentation, shipping, handling, and packaging procedures. Nevertheless, no literature to date has empirically investigated the prevalence of international modal, port, and package selection strategies employed by U.S. logistics professionals. In an effort to identify the consistency in the way U.S. logisticians cope with more challenging global operations, this study analyzed the empirical data obtained from 63 U.S. multinational firms which mostly represented the U.S. manufacturing sector. Several findings are noteworthy.

First, because longer distance deliveries are more common to foreign customers, both transportation time and cost have become overriding factors for selecting international transportation modes. As such, international logistics professionals are addressed always to carefully scrutinize the potential impact of modal choice on transportation cost and time. In

particular, considering different transportation pricing methods, services and modal availability in different countries, the international modal selection decision must consider the tariffs, classifications, rate negotiability, inland transportation networks, routes, and outsourcing opportunities in the destination country. Furthermore, beyond the understanding of the aforementioned logistics complexities, logistics professionals must fully understand the wide range of exogenous variables that vary from country to country. These variables include language, culture, regulations, geography, and political structure.

Second, reflecting the significance of transportation cost and time to global logistics operations, the assurance of timely delivery services and inexpensive freight rates has emerged as the most important agenda for international freight term negotiation. The establishment of a world-wide information network is strongly suggested in order to give international shippers substantial bargaining strength, because it will enable the shippers to access up-to-date information about foreign freight rates and service performance history of available modes around the world. That is to say, international strategy should coordinate information flows around the world, while controlling the corresponding physical flows.

Third, irrespective of the size of firms, excessive paperwork needed for exporting/importing has become the biggest stumbling block for international logistics. Although familiarity with country-unique trade rules, regulations, and specifications may ease the headache created by document preparation, unsuspected errors in documentation can still lead to costly shipping delays and financial penalties. Perhaps one of the most effective ways of minimizing such errors is to utilize the services of third-party logisticians such as foreign freight forwarders, customs house brokers, and overseas distributors who can undertake the necessary paperwork accompanying international shipments. In addition, the use of a world-wide communication and information system similar to the one proposed by Min and Eom[23] may not only simplify export/import documentation through "paperless" data transmission, but also enhance communication with foreign business partners through data sharing.

TABLE 6
Attributes Leading to Effective International Packaging

Attribute	Degree of Importance, on Average		Rank
Prevention of handling damage (resiliency)	1.455	(0.633)	1
Dimensions for best use of space	2.038	(0.898)	2
Weather protection	2.115	(1.114)	3
Package material cost	2.189	(0.833)	4
Meeting carriers' requirement	2.630	(1.051)	5
Conform to regulations on hazardous items	2.685	(1.540)	6
Weight distribution for containerization	2.698	(1.067)	7
Package disposal cost	2.755	(0.979)	8
Reusability	3.113	(1.031)	9

Note: Numbers in parentheses represent standard deviations of scales.

Scale for the Degree of Importance
1 = Extremely important
2 = Somewhat important
3 = Neither important nor unimportant
4 = Somewhat unimportant
5 = Not at all important

Fourth, to prevent shipping delays and interruptions at intermodal exchange points, international shippers tend to choose the destination port located near to inland waterways, railways, or highways. In other words, unless the connecting ports are heavily congested and ill-equipped for containerization, international intermodal traffic tends to gravitate toward seaports or airports which are geographically positioned by most effective transport links.

Finally, despite the frequent use of well-protected containers in international shipping, the most important function of international packaging appears to be damage protection (resiliency). Therefore, international shippers tend to favor more protective packages often made of corrugated, palletized, and film-based materials that can withstand mishandling, rough rides, excessive heat and high humidity, while not increasing package material cost. However, considering that much of the recent environmental legislation across the world is directed toward distribution packaging, logistics professionals should develop an effective green packaging strategy by utilizing more innovative packages such as high density polyethylene pallets and moisture absorbing desiccant packets.

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INTERNATIONAL LOGISTICS STRATEGY SURVEY

Please check the choice which best represents your response to each question.

COMPANY INFORMATION

1. Indicate the classification which best describes your firm.

- ☐ Manufacturing: consumer
- ☐ Manufacturing: industrial
- ☐ Financial services
- ☐ Other (Please specify): _____
- ☐ Energy: oil and gas
- ☐ Government: state and federal
- ☐ Utilities
- ☐ Retail trade
- ☐ Wholesale trade
- ☐ Transportation and warehousing

2. How many employees does your firm employ?

☐ 1-99 ☐ 100-499 ☐ 500-999 ☐ 1000-4999 ☐ 5000 or more

3. How many employees work in your transportation/logistics unit?

☐ 1-2 ☐ 3-4 ☐ 5-10 ☐ 11-20 ☐ 21-49 ☐ 50 or more

4. How much was your company's 1993 (or most recent year's) total sales (in dollar value)?

☐ less than $1 million ☐ $1 - $19.9 million ☐ $20 - $99.9 million ☐ $100 - $299 million
☐ $300 - $499 million ☐ $500 - $999 million ☐ $1 billion or more

5. What percent of your company's 1993 (or most recent year's) total shipping was overseas?

☐ less than 5 ☐ 5 - 10 ☐ 11 - 20 ☐ 21 - 40 ☐ 41 - 60 ☐ 61 - 80 ☐ 80 or more

INTERNATIONAL SHIPPING PRACTICES

6. Please indicate the regions of the world to which you ship. (✓ all that apply.)

- ☐ Western Europe
- ☐ Pacific Rim including Oceania
- ☐ North America
- ☐ Eastern Europe
- ☐ Other Asia such as India
- ☐ Central America
- ☐ Middle East
- ☐ Africa
- ☐ South (Latin) America

7. Please indicate the annual volume of international shipping made via each of the following transportation modes. (✓ all that apply.)

Modes:	None	Less than 100 lbs.	100-999 lbs.	1,000-4,999 lbs.	5,000+lbs.
Air carrier	☐	☐	☐	☐	☐
Ocean carrier	☐	☐	☐	☐	☐
Rail carrier	☐	☐	☐	☐	☐
Motor carrier	☐	☐	☐	☐	☐
Pipeline	☐	☐	☐	☐	☐
Piggyback	☐	☐	☐	☐	☐

8. Please indicate how you book international cargo. (✓ all that apply.)

□ Directly

□ Through a foreign freight forwarder

□ Through a shippers association

□ Through a Non-vessel-owning common carrier (NVOCC)

□ Through a broker

INTERNATIONAL MODAL CHOICE

9. Please rate the importance of the following factors in your firm's choice of international transportation mode by circling the appropriate number.

	Extremely important				Not at all important
Shipment size	1	2	3	4	5
Average transit time	1	2	3	4	5
Transit time variability	1	2	3	4	5
Transportation cost	1	2	3	4	5
Cargo damage risk	1	2	3	4	5
Insurance coverage	1	2	3	4	5
Types of cargo packages	1	2	3	4	5
Type of cargo being shipped	1	2	3	4	5
Convenient schedules	1	2	3	4	5
Geographic coverage	1	2	3	4	5

10. Please indicate the form of intermodal service your firm has used. (✓ all that apply.)

□ landbridge

□ minibridge

□ microbridge

SUBJECTS OF FREIGHT TERM NEGOTIATION

11. Please rate the importance of the following factors as they relate to international freight term negotiations by circling the appropriate number.

	Extremely important				Not at all important
Freight rate	1	2	3	4	5
On-time delivery	1	2	3	4	5
Damage claims liability and handling	1	2	3	4	5
Insurance coverage	1	2	3	4	5
Rate revisions	1	2	3	4	5
Shipment tracing	1	2	3	4	5
Containerization	1	2	3	4	5
Mode of transportation	1	2	3	4	5

12. What is (are) your main form(s) of international freight term negotiations? Choose more than one choice, if necessary.

□ Face-to-face negotiations

□ Telephone/Telex negotiations

□ Negotiations through third party logisticians (mediators)

□ Other (Please specify): _____

INTERNATIONAL PORT SELECTION

13. Please rate the importance of the following factors as they affect the international port selection by circling the appropriate number.

	Extremely important				Not at all important
Special equipment availability	1	2	3	4	5
Cargo damage/loss protection	1	2	3	4	5
Convenient pickup/delivery schedules	1	2	3	4	5
Easy access to in-land modal transfer	1	2	3	4	5
Low freight handling charges	1	2	3	4	5
Facilities for large/odd-size freight	1	2	3	4	5
Faster loading/unloading services	1	2	3	4	5

14. Do you think that packaging for international shipping should be significantly sturdier than packaging for domestic shipping?

□ Yes □ No

15. If you answered "yes" to the above question, please indicate the reason why. (✓ all that apply.)

□ Lengthy transit distances
□ Intermodal transfer of cargoes
□ Customers inspections
□ Tougher international packaging regulations
□ Difficulty in resolving damage disputes

16. Please rate the importance of the following factors as they influence international packaging design decisions by circling the appropriate number.

	Extremely important				Not at all important
Prevention of handling damage (resiliency)	1	2	3	4	5
Package material cost	1	2	3	4	5
Package disposal cost	1	2	3	4	5
Reusability	1	2	3	4	5
Weather protection	1	2	3	4	5
Conform to regulations on hazardous items	1	2	3	4	5
Meeting carriers' requirements	1	2	3	4	5
Weight distribution for containerization	1	2	3	4	5
Dimensions for best use of space	1	2	3	4	5

17. Please indicate the most typical type(s) of international packaging you use. (✓ all that apply.)

□ Palletized cardboards or foams
□ Barrels
□ Wood crates, boxes, and baskets
□ Custom-built disposable woods or foams
□ Plastic film bags
□ Polyethylene films
□ Others (Please specify) _____
□ Corrugated fiberboard cases
□ Steel, plastic pails, and wood kegs
□ Steel, plastic, and fiber drums
□ Paper balers
□ Multiwall paper sacks
□ Polyvinyl chloride films

OBSTACLES IN INTERNATIONAL LOGISTICS

18. Please rate the seriousness of the following obstacles in international logistics by circling the appropriate number.

	Very Serious				No problem at all
Documentation requirements	1	2	3	4	5
Damage claims disputes	1	2	3	4	5
Modal incompatibility	1	2	3	4	5
Lengthy transit time	1	2	3	4	5
Customs barriers	1	2	3	4	5
Difficulty in freight rate negotiations	1	2	3	4	5
Cargo insurance arrangements	1	2	3	4	5
Foreign governments' regulations	1	2	3	4	5
Miscommunication	1	2	3	4	5
EDI incompatibility	1	2	3	4	5
Loading/unloading delays at foreign ports	1	2	3	4	5
Global outsourcing	1	2	3	4	5
Cultural differences	1	2	3	4	5

19. Do you think an international logistics strategy should be different from the domestic logistics strategy due to the existence of various obstacles in international logistics?

□ Yes □ No


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