Business Logistics

From Push to Pull Logistics[1]

Executive Summary

The migration from manufacturing-based "push" logistics systems to "direct-placement" or "pull" networks has appeared as an emerging trend in physical supply and demand coordination. The implications of any large-scale migration to "pull" logistics could be significant for a national freight productivity program.

To determine whether or not manufacturers are indeed shifting from a "manufacture-to-supply" or "inventory-based" logistics model to a "manufacture-to-order" or "replenishment-based" logistics model, we conducted a series of interviews with major shippers and transportation providers.

Our interviews suggested that of the two dominant logistics models in use, inventory-based logistics prototypes still dominate among most large-scale manufacturing and distribution firms. Inventory-based logistics also represents the primary model for "E-tailing" (Internet-based retailing): national or regional warehouses supplying home and business delivery with airfreight and package delivery services.

The manufacturers and retailers we interviewed believed that replenishment-based logistics systems offered efficiency versus traditional inventor-based models, but were reluctant to risk the increased stockouts perceived to accompany replenishment models. We found little evidence of pure pull systems in high-volume logistics applications. The companies interviewed did not anticipate a major shift over the next decade, but rather a gradual expansion of pull systems in response to increasing pressure to improve customer service and still reduce inventories. Most interviewees believed that a "blended model" would emerge as the dominant system: one that incorporates elements of both push and pull systems. For example, General Motors (GM) logistics strategy still incorporates built-up inventories for finished goods (automobiles), but is seeking to adopt more "pull" logistics on the supply-side (auto parts). Conversely, DuPont has implemented pull-logistics systems for the distribution of industrial and consumer products, but has

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maintained an inventory-based model for supply logistics due to the high cost (in production inefficiency) of stockouts, and the inconsistency of current rail services.

Despite the slow adoption of pull logistics among major manufacturing and retailing firms, the interviewees suggested that several related factors could significantly affect the rate at which replenishment-based models are implemented. These factors include (1) the rate of e-commerce growth, (2) the shift to smaller shipping quantities, (3) the migration to customer-direct delivery, and (4) the growth of 3rd and 4th party logistics services. Our interviews suggested that an increase in the rates of change for any or all of these factors would presage increased adoption of replenishment systems in their sectors. Working as a strong deterrent to the adoption of "pull" logistics models is carrier performance. The shippers we interviewed strongly believed that carrier services were not sufficiently reliable to allow them to significantly reduce or eliminate safety stocks.

Although "pull" logistics are considered to be economically superior to the inventory-based systems that are still prevalent, the transformation is taking place very slowly. While several emerging trends – such as the growth of direct delivery -- could significantly alter the current adoption rates for replenishment models, other factors – such as inconsistent carrier performance – will continue to restrain the evolution.

Introduction

Migration from manufacturing-based "push" logistics systems to "direct-placement" or "pull" networks has appeared to be emerging trend. The theory behind this trend is that timely access to point-of-sale transaction information allows manufacturers to reengineer production and distribution processes around the replenishment of sold inventory, rather than the production of "likely-to-sell" stock. Such a shift is expected to result in improved production efficiency, reduced stock discounting, and significantly lower levels of inventory. "Pull" systems have been a much-touted innovation in logistics, and have been most closely associated with Internet-based retailing ("e-tailing") firms such as Amazon.com.

David Simchi-Levi, a Professor of Engineering Systems at MIT, recently commented[i] on the emergence of this trend, noting that:

> *"…many firms are shifting from "push" systems - in which production decisions are based on forecasts -- to "push/pull" systems, in which the assembly of finished goods is based on actual customer demand, and parts/raw materials inventory is replenished based on forecasts."*

But while the application of "pull" logistics is apparent in "dot-com distribution", the degree to which this trend has taken hold in more traditional channels is less certain. Some logistics analysts believe the shift is apparent in heavy industrial sectors, such as automotive. J. Ferron, a partner at PricewaterhouseCoopers in Detroit believes[ii] that:

> *"Consumer demand is forcing automakers to shift from a supply chain where they "push" inventory to dealerships to one where consumers "pull" product. To compete, manufacturers will need to operate with a lower cost structure and more agility."*

The implications of a large-scale movement to "pull" logistics could be significant for a national freight productivity program. Partly in an effort to validate this trend, we conducted a series of interviews with transportation executives from around the country. These interviews offered us the opportunity to verify the extent to which "pull" logistics systems are employed in industrial and consumer logistics systems, and to estimate the degree to which this trend will expand over the next decade. This analysis combines the results of those interviews with secondary research, and attempts to develop a series of conclusions and policy recommendations specific to the issue of "push versus pull" logistics.

Trends

Evidence of a Trend to the Pull Logistics Model

Our goals for this aspect of analysis were threefold. First, we sought to determine if manufacturers are indeed shifting from a "manufacture-to-supply" or "inventory-based" logistics model to a "manufacture-to-order" or "replenishment-based" logistics model. Second, we sought to identify to what degree this trend already is evident in the logistics marketplace. Third, we sought to assess the likelihood that this movement would expand over the next decade. As background, the basic theory of product resupply can be divided into two main models: "inventory based" versus "replenishment based" logistics. The primary differences between the two types are described below.

Inventory-based Logistics Models

Inventory-based models presume that production is scheduled based on forecasted demand, and retail or industrial deliveries are made from pre-manufactured inventory. That inventory is generally placed in a warehouse or distribution facility near the production site (conventional), or "forward-placed" near the customer. Often inventory-based systems combine both conventional and forward placed inventory, making frequent distribution center (DC) to distribution center transfers. As forward placed warehousing is generally more expensive to obtain and operate (locations are generally more urban), historical practice has been to maintain large warehouse facilities in more remote (suburban and rural) areas, and smaller more nimble "forward" DC's. Many firms have found that the cost of airfreight transportation from remote DC's is a reasonable trade-off against the sometimes high-cost of forward-placed inventory and ground transport.

Replenishment-based Logistics Models

Replenishment-based models suggest that product manufacturing is coordinated to actual point-of-sale transactions, and that resupply is made directly from the production site. The purchase of an item in a retail or industrial transaction prompts the production of a

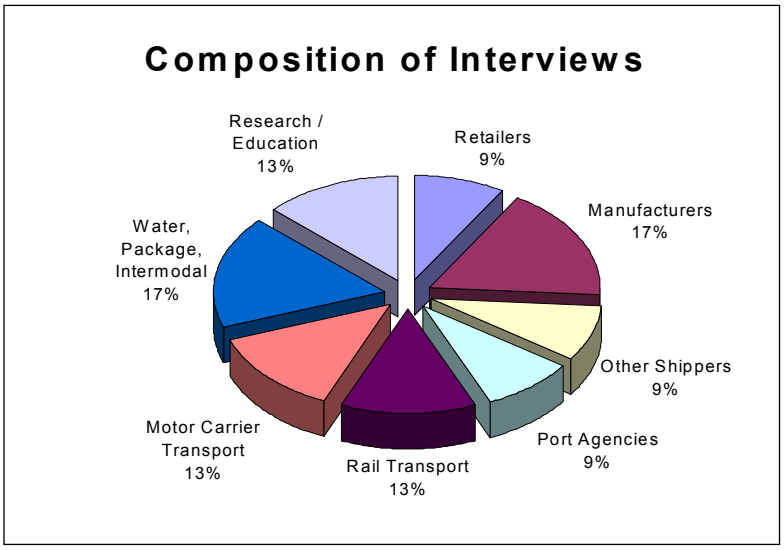
like item for replacement. Overall inventory levels are minimized, as completed units are either at the transaction site, or in-transit to the transaction site (from the manufacturer) as a replacement for a sold item. A true replenishment-based logistics program seeks to eliminate stock inventory, and re-supply sales inventory directly from production.

Implications

Widespread implementation of pull logistics systems should result in lower inventory levels and less slack production capacity. These changes would naturally create a greater dependence on in-transit inventory as the primary source of replenishment stock, and reliable transportation service as a critical component of effective merchandising. It would also be expected that any broad adoption of "pull" systems would place an additional burden on high-service infrastructures. The expected increases in airfreight and high-service truck transport would force additional traffic on already congested networks and exacerbate congestion issues.

Findings

In the course of the interviews conducted with numerous transportation professionals[iii], it was determined that the application of true pull logistics models is very limited. Furthermore, the appearance of these programs is generally not in primary industrial and retail industries, but among specialty producers and retailers for whom stock-outs are infrequent because of low transaction volumes. Much of the current logistics environment appears to be a "blended model": one that incorporates elements of both push and pull systems.



Most of the interviewees indicated that while their primary distribution strategies remain inventory based, they have adopted more pull-like retailing strategy. This trend seems to be evident for both retail and industrial manufacturers. For example, General Motors (GM) currently maintains comprehensive electronic field inventories for many vehicle lines. If a particular dealership does not have a specific model in stock, a search of the database can reveal the closest available matching unit. A simple dealer-to-dealer vehicle transfer can then deliver the car to the customer in a matter of days. In this way GM has been able to reduce total vehicle inventories, and increase the likelihood of a sale. GM is working to integrate this retail model into the Company's overall logistics strategy through the construction of regional vehicle storage locations. These centers could reduce field inventories overall, and potentially support the gradually emerging E-tailing of automobiles.

While a vast improvement over previous retailing methods, GM's logistics strategy still incorporates built-up inventories. The limited number of option combinations and the high risk of lost sales due to stock-outs will probably limit the expansion of pull logistics programs in automobile distribution. In fact, Mike Hrivnak, Director of Rail Transportation for General Motors, asserts that true pull systems are unlikely to emerge for the automobile industry in the next decade. GM, and many other heavy-industrial firms have found a more fertile opportunity for pull-logistics on the supply-side, and have worked with parts suppliers and subassembly providers to develop manufacture-to-order logistics systems. The linkage of information systems allows these firms to pick, assemble, pack, and ship parts to GM's vehicle assembly plants only hours before they are installed in a finished vehicle.

Similarly, DuPont has seen only limited application of pull-logistics systems for their line of industrial and consumer products. Mary Pileggi, Manager of Rail Operations for DuPont USA, sees this trend as being driven more by customer service demands than by inventory reduction programs. For DuPont's industrial chemicals and compounds, pull logistics is barely evident. The overwhelming economics of large production batches has led the Company to forward place product inventories (generally in multiple railcar quantities) at customer sites. Similar batch economies exist for many of DuPont's industrial chemical customers. This field inventory allows DuPont to provide their customers with consistent and timely replenishment. DuPont has found that transit consistency -- rather than speed – to be the most critical element of implementing "lean inventory" programs. Thus even slower rail and water transport have become integral components of their replenishment systems. Recently however, inconsistent railcar delivery has prompted DuPont to postpone efforts to implement pull-type logistics systems, electing instead to maintain larger on-site customer inventories.

Conclusions

The results of the interviews suggest that the emergence of true pull systems among large volume shippers is extremely limited. More evident is the gradual blending of traditional push and newer pull systems. The application of pull systems appears more widespread in physical supply systems, and at the very ends of physical distribution systems. There was no evidence of pure pull systems in the analysis, particularly in high-volume logistics applications.

The companies interviewed – significant players in the logistics market – did not anticipate a major shift over the next decade, but rather a gradual expansion of pull systems as a technique to serve customers better and reduce inventories. The manufacturers and carriers interviewed were content to allow the gradual expansion of pull systems in the logistics marketplace. These individuals believed that whatever migration does occur will be determined as a result of other issues – or trends – in the logistics marketplace; several of which are described below.

Trends Impacting Logistics Model Migration

Despite the evidence that adoption of pull logistics is moving slowly, the interviews suggested that several related trends could significantly affect the rate at which more sophisticated logistics models are implemented. The additional trends that emerged in

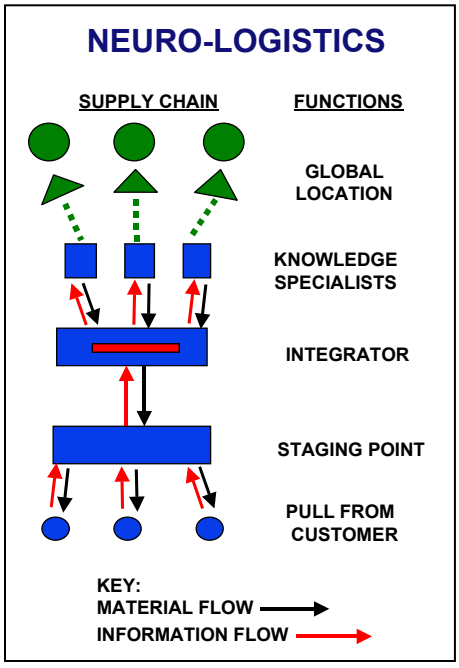
the freight scans were (1) the growth of e-commerce, (2) the shift to smaller shipping quantities (3) the migration to customer-direct delivery, and (4) the growth of 3rd and 4th party logistics services. We sought to develop through the interviews, a better understanding of the linkages that exist between these trends and the movement from push to pull logistics systems.

Findings

E-Commerce. The revolution of E-commerce has been broadly divided into two categories: Business-to-Consumer (B2C) and Business-to-Business (B2B). Business-to-consumer transactions – such as an individual's order of a book from Amazon.com - are generally viewed as the substitution of an electronic transaction for an in-person, telephone, or mail-order transaction. The impact on the logistics system of such transactions has contributed to the increase in small package movement. These are, in many cases, "new" logistics activities using commercial assets (a UPS shipment) to accomplish something previously handled with a personal asset (an individual's car). While this growth has been significant, the relative number of transactions remains small. Business-to-business transactions, on the other hand, generate significantly more volume, and thus the E-commerce implications of B2B shifts are significant.

While the hype surrounding B2C e-commerce has far exceeded actual results, there remains a systematic progression toward increasing B2B electronic commerce. For many firms we interviewed, B2B applications of e-commerce are little more than an incremental expansion of Electronic Data Interchange (EDI). Generally, the interviewees did not distinguish between the two, indicating that EDI is now subsumed in e-commerce.

Common logistics applications of E-commerce in business include booking freight transport or load matching (either directly or via a 3PL). Both carriers and shippers alike indicated their firms were pursuing opportunities to expand the use of electronic communications for logistics applications. Most also indicated that the bulk of current activities are not transactional, but rather informational. B2B E-commerce seems to have had little direct impact on logistics: a truckload tendered through an E-com transaction is still a truckload movement, and an airfreight pick-up dispatched through an e-commerce transaction has not resulted in a modal shift.



The interviews also suggested that despite the publicity, there is not currently a significant degree of e-commerce activity among traditional industrial firms. One DuPont representative indicated that many transactional processes are still via traditional telecommunications links such as telephone and fax. Another believed that the use of 3rd party services has helped progress e-commerce applications.

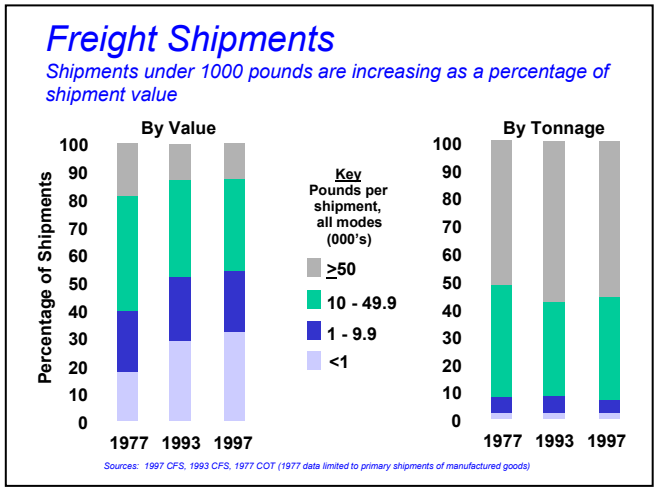
Woody Richardson, of Schneider National, agrees that e-commerce has not significantly impacted their business processes as yet, but he believes that over the long term the effects will be profound. E-commerce, he feels, provides the information necessary to optimize both pricing and service - and as information improves, it will propel carriers toward greater operating efficiency. Moreover, and equally important, the attraction of e-commerce is a reflection of deeper social change. The huge business-to-business market has a substantial component that supplies consumer goods through the retail channel. As consumers allocating their time begin to substitute electronic for in-person shopping, it changes the value of keeping goods on the retail shelf, which is the defining feature of the traditional channel. Arguing that society transforms distribution, Schneider expects the rise of new logistical channels that accommodate changes in the behavior of consumers, who now have new options available.

Respondents agreed that the expanding application of information technology to the logistics model has resulted in the evolution of a new style of logistics process – the so-called "neuro-logistics" model. "Neuro-logistics" fuses information systems with physical logistics processes to create more responsive and leaner supply and distribution networks. Information is substituted for inventory in its role of managing stock-out risk, which several executives cited as a real phenomenon and source of continuing productivity gains.

Shift to Smaller Order Quantities

There is both empirical and anecdotal confirmation that shipment sizes are indeed shrinking. This trend appears to be rooted in inventory reduction and supply chain management programs, although the growth of e-commerce has an accelerating influence.

Rising inventory unit costs and more rigid customer demands have combined to make package and airfreight re-supply an economical alternative to forward placement of inventory. General Motors offers evidence of this trend in its Service Parts Organization (parts re-supply to dealerships). There, a restructuring of distribution activities around smaller shipments has been a means of providing better service to GM's dealer network.

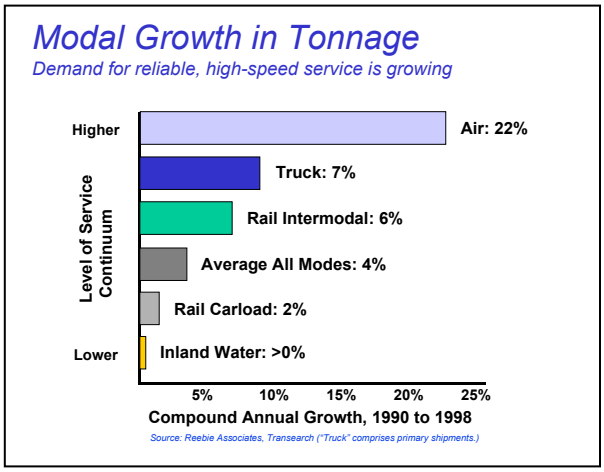


Similarly, executives at Yellow Freight have seen shippers opting for more expedited delivery services, reasoning that while transportation costs increase, overall supply chain costs decrease. Other shippers agree, citing inventory reductions, or "rescued" sales (sales that would otherwise be lost due to slow delivery) as rationale for expedited services.

In the rapid growth sector of B2C e-commerce, retailers are

constructing vast distribution centers (so-called "Bricks & Clicks" distribution) proximate to air freight hubs, creating land-use problems in high-demand areas. Jack Fracker, Executive Director of Cushman & Wakefield – a real estate development form, indicates that "in centrally located areas, demand for industrial space far exceeds supply."[iv] Sites convenient to Federal Express' Memphis, Tennessee hub are fetching top dollar, and cities like Allentown, Pennsylvania have seen double-digit warehousing growth because of their proximity to major East Coast markets.

The movement towards smaller shipping quantities and hence smaller package logistics is one that should significantly influence the rate of adoption of pull logistics systems, and may in fact represent a "leading indicator" of additional logistics model migration. The respondents clearly recognize the linkages, but are unsure of the collateral impacts. Both shippers and carriers are watching this trend closely for larger implications to their respective logistics systems.



Shift to Customer-Direct Delivery

Another significant trend that appears to be influencing the rate of migration towards pull logistics systems is an explosion in customer-direct delivery. The competitiveness and effectiveness of air freight carriers and package delivery companies in providing efficient ground delivery service has, in many cases, eliminated several links in traditional supply chains. Residential deliveries have reduced trips to retail establishments for many items from food to automobiles. Mail order companies ship many products directly from manufacturers and eliminate intermediate warehousing and distribution. As evidence of this trend, Les Passa, former President of CSX Intermodal, commented that he has seen a significant decline in traditional DC-to-DC movements, and a corresponding increase in package traffic volumes[v]. David Simchi-Levi of MIT notes that:

> *"The move to push/pull systems means that more firms are shipping products directly to customers, thus bypassing traditional supply chains. With more direct-to-consumer-business, many firms will need to adjust their transportation mode away from bulk shipments toward parcel shipments, creating an increase in demand for small package delivery as more consumers shop on the Internet."*[vi]

DuPont agrees, estimating that 70-80% of the Company's domestic truck shipments are now direct-to-customer deliveries. For DuPont's consumer products, such as Tyvek® house wrap, these deliveries are often made directly to construction job sites.

A looming challenge for this trend is taming the "last mile" delivery costs, which remain unacceptably high even for the most efficient carriers in the marketplace. This has been evident in the failure of several high-profile dot-com companies that specialized in home

delivery of small low-value packages, as well as the reluctance of FedEx and UPS to provide universal home delivery to all addresses.

Woody Richardson of Schneider National commented[vii] that he believes that several potential customer-direct distribution models are vying for success but at the moment no clear winner is apparent. He infers that the rise in customer-direct delivery is a function of consumer time-use decisions rather than inventory management principles. One possible distribution model has goods moving directly from a plant to a home delivery consolidation center or cross-dock center, and thence to residences. This approach eliminates several stages of handling from the traditional channel. As a version of the pull model, it could significantly reduce total logistics and transportation costs for consumers, by creating long haul lanes with concentrated volumes. Whatever system ultimately emerges, the implications for logistics patterns will be significant.

The Shift to Greater 3PL and 4PL Participation

Another trend that appears to affect the rate of migration to pull systems is the growth of 3rd and 4th party logistics providers. While 3rd party providers have been around for some time, the 4th party phenomenon is relatively recent. Jack Roeser, a longtime logistics consultant, defines the difference between a 3PL and a 4PL provider in this way:

> *"[A 4PL] acts as the integrator of multiple 3PLs all working for a company which requires multiple 3PL services, no 3PL having the ability to provide all of the required services itself. The multiple 3PLs work through the integrator to the company itself. The 4PL integrator…is the direct contact to the company."*[viii]

Industry executives interviewed felt the differences were more definitional than practical. Officers at Yellow Freight haven't really seen anyone effective as an integrator on a large scale. Indeed, most integrators are small. They believe that the expansion of integrator roles is a function of customers' willingness to give up control.

Despite the growth in 3rd and 4th party logistics services, the market appears to be expanding more laterally than vertically. An annual survey conducted by Boston's Northeastern University and Mercer Management Consulting of third-party usage by major manufacturing companies, indicates that over 60% of the services offered by 3rd party providers are simple transportation services, and nearly 50% are warehousing services[ix].

DuPont is a believer in 3rd party services, and has outsourced much of its truckload and LTL transportation processes to APL Services in Charlotte, NC. APL coordinates the load booking, tracing, billing claims and carrier evaluation efforts for DuPont. Of critical importance is carrier safety; APL provides the information DuPont needs to keep tabs on carrier safety performance. But, DuPont would also like wider product offerings from 3rd party providers.

General Motors is also looking at large scale outsourcing opportunities, and anticipates significant outsourcing of GM's worldwide logistics activities in the near future. With

substantial experience in worldwide delivery, airfreight carriers are seen as the front-runners in this process.

Outsourcing the Supply Chain

The emergence of 3PL's and 4PL's is one sector of the broader "outsourcing" trend. Our interviews suggested that firms pursue outsourcing based on two key principles:

(1) The desire to focus scarce corporate resources on core functions such as production or marketing and outsource secondary functions to specialty firms, or

(2) The perceived lack of in-house logistics or information technology skill to develop and maintain complex logistics networks, and the availability of these capabilities in the marketplace. In fact, logistics outsourcing is on the leading edge for several of the firms we spoke with.

The 1997 Global Supply Chain Study, developed by KPMG Consulting and the J.L. Kellogg Graduate School at Northwestern University found that among 451 companies [located in 24 countries across eight industry segments], 54 percent had outsourced transportation services, while about 30 percent had outsourced other supply-chain functions, including manufacturing, warehousing, and logistics information systems[x]. Third and 4th party Logistics companies account for nearly all of this outsourced activity[xi].

Responding to these customer programs, 3rd and 4th party logistics companies often build themselves around information systems platforms that permit greater pipeline visibility and lower transaction costs than most shippers can attain by themselves. By leveraging these coordination skills, the 3PL's and 4PL's are hoping to make the business profitable. But profits have been elusive. A Northeastern University survey of 3rd party CEO's indicates that a majority believes that the industry is only marginally profitable, and that the difficulty and expense of implementing new contracts will make profitability difficult to sustain[xii].

Schneider questions the ability of integrators to bring value. They perceive heavy administrative costs in conducting the role effectively, and question whether the cost of technology may exceed the benefits for the customer. Consequently, such winners as may emerge among integrators will be those with the biggest pockets.

The growth of 3rd and 4th party logistics services represents a positive step for more widespread implementation of pull logistics systems. The technology and experience these companies provide is often the precursor to more sophisticated logistics model implementations. As logistics systems grow more complex, however, 3rd and 4th party providers struggle with implementation costs and shipper control issues. The tension in this area is as yet unresolved, and thus the impact on the expansion of pull logistics models remains somewhat uncertain.

Implications

Carrier Preparedness for Pull Logistics Models

Pull logistics models, through the reduction of inventories and the elimination of safety stocks, rely heavily upon carriers to perform timely replenishment of products and avoid stock-outs. A recurring theme from shipper interviews, however, is that carriers have not kept pace with the changing logistics requirements of the marketplace. Shippers have invested considerable time and expense in contingency planning and service recovery programs to preserve manufacturing and retail continuity in the face of service interruptions. General Motors believes that rail service is much worse than 10 years ago. Of the approximately 50,000 railcars shipped by GM in 2000, only around 50% arrived within 24 hours of their expected delivery.

DuPont agrees, and, as a result of current service levels, they have been forced to add inventory to pipelines and railcars to the fleet, to maintain customer delivery commitments. Shippers generally indicated that carrier performance is a significant roadblock to continued inventory reduction initiatives like pull logistics.

Carriers tend to believe that their own service performance has risen, but are less complimentary about their industries as a whole. Moreover, they are having difficulty capitalizing the technological improvements required to manage more sophisticated logistics processes. CSX Intermodal has looked to third party technology and experience to intervene. Railroads and trucking companies are faced with significant investment in upgrading basic operating systems, and are reluctant to make investments in leading-edge logistics technology tools. And to make matters worse, shippers' expectations are rising.

Executives at Yellow Freight agree that disruptions in the low-inventory supply chains can take place more readily now. They are concerned, however, that too little is being done to prepare for them. With the current pressures to reduce logistics costs, there is not much incentive to build in redundancy. The parties agree that service disruptions are likely and are apt to ripple through the economy more rapidly than in the past, but that the private sector is generally unprepared.

In addition, the pressure to reduce rates, combined with higher costs of capital, fuel, and insurance, has squeezed many carriers to the breaking point. Yellow Freight reflected that consolidation in the LTL industry has historically taken place through business failures, not through mergers. They predict more of the same in both the LTL and truckload sectors.

Finally, carriers continue to wrestle with security issues. CSXI sees a more sophisticated criminal involved in cargo theft. With the "upscaling" of criminal activity has come a trend to more violent and sophisticated thefts. Cargo theft has graduated from a box lifted from the loading dock, to gunpoint hijackings of entire trailers or containers. CSX

Intermodal has begun to work more closely with local police in an attempt to protect cargoes. In addition, they have expanded the use of sting operations to catch well-outfitted criminals, who often use cellular phones and two-way radios to communicate the location of valuable cargo or law enforcement forces.

The results of the interviews suggest that carriers may not be prepared to provide the service quality and consistency that an expansion of pull and neuro-logistics systems would require. The inability to fund technology investments and the inconsistency of many current service offerings are combining to limit the application of the more sophisticated logistics models. Until significant changes occur in this area, it appears that the productivity improvements available through pull logistics models will not be realized in the near term.

Issues

While theorists suggest that pull logistics systems are fast replacing more traditional push models, the interviews suggest that this conversion is taking place very slowly. Several factors are limiting this migration, including advanced information systems, inconsistent carrier performance and batch production economics. Much of the emergence of pull systems has been at the outer ends of the supply chain – in physical supply or retail commercial transactions. There, areas have converted more quickly because of several prominent trends in logistics including, consumer driven e-commerce, smaller shipment sizes (a by-product of aggressive inventory reduction programs) and expanding direct delivery. As these initiatives become more widespread - a fact agreed upon by nearly all of the respondents - a more rapid expansion of pull systems is anticipated.

Carriers are aware of the conversion to pull models, but as a result of the competitive rate market, some have been unable to capitalize the costly information systems necessary to raise service and reliability levels to accommodate the new logistics processes. Even so, there is a strongly held belief that information technology is a clear route to higher service performance.

Shippers are continuing to capture additional logistics savings through the expanded use of 3PL and 4PL providers. Among 3PLs, the service offerings are generally ubiquitous. Shippers expressed interest in outsourcing a broader range of functions, but providers, struggling with the profitability of "cookie-cutter" services, are reluctant to absorb the risks of development investments. The integrator role, a form of super supply chain management, has yet to move from theory to reality as carriers and shippers alike remain skeptical of the incremental value of integration activities. At present, all parties seem content to let theses trends emerge slowly.

Given that a rapid expansion of pull logistics models may not be imminent, government policies probably can evolve to accommodate the more gradual shift that seems to be

taking place. Stresses on air cargo and package delivery facilities are anticipated to increase the most over the next decade, as the shift to smaller and faster resupply systems expands. Still, distribution channels themselves are in flux, and new designs for the production of density and the associated service economies can be expected to rise.

- Continuing changes in business-to-consumer (B2C) logistics activities will give the first indication of a shift in the broader logistics network, but the marketplace's tolerance for change in B2B is substantially less.

- Land use management issues will continue to emerge in connection with the reduction in shipment sizes. Air cargo hubs such as Memphis and Louisville will quickly reach saturation and new air cargo hubs will emerge.

- The high cost of information systems development appears to represent a roadblock to additional pull logistics implementation.

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[i] Simchi-Levi, David, Professor of Engineering Systems. The Supply Chain and the New Economy. Speech given at MIT Affiliates Day 2000 (hosted by UPS: Louisville, KY). October 2000.

[ii] Automakers shift to "pull" strategy. Logistics Management & Distribution Report. January 1, 1999.

[iii]

Composition of Interviews	Number
Retailers	2
Manufacturers	4
Other Shippers	2
Port Agencies	2
Rail Transport	3
Motor Carrier Transport	3
Water, Package, Intermodal	4
Research / Education	3
Total	23

[iv] Deutsch, Claudia H. Bricks-and-Clicks World Needs Commercial Space. *The New York Times*. October 30, 2000.

[v] Personal interview, August 2000.

[vi] Simchi-Levi, David, Professor of Engineering Systems. The Supply Chain and the New Economy. Speech given at MIT Affiliates Day 2000 (hosted by UPS: Louisville, KY). October 2000.

[vii] Personal interview, August 2000.

[viii] Roeser, Jack. http://www.logistics-aug.com/.

[ix] Foster, Thomas A. View from the top: How third-party CEOs view their industry. Logistics Management & Distribution Report. August 1, 1999.

[x] Logistics Management and Distribution Report. March, 1998.

[xi] The balance is Contract Manufacturing. While traditionally not considered a 3rd or 4th Party logistics activity, 3PL firms such as CTI and Penske Logistics do perform light manufacturing and assembly for several clients.

[xii] Foster, Thomas A. View from the top: How third-party CEOs view their industry. Logistics Management & Distribution Report. August 1, 1999.