# Technology and Location of Freight Transportation, Distribution, and Manufacturing Jobs 6

Innovations in transportation and production technology have significantly affected the spatial distribution of the goods sector and have led to decentralization of activities away from older urban cores. Many believe that in contrast to services, particularly information-based services, the manufacturing, transportation, and distribution sectors are less affected by the current revolution in information technologies. However, new information, transportation, and production technologies are in fact contributing to the decentralization of these sectors. Much of the goods production, transportation, and distribution jobs that core cities have depended upon will continue to decentralize to outer suburban and exurban areas and to lower-cost, smaller and mid-size metropolitan areas. Yet, for some operations, particularly those involving more flexible and smaller-scale production and distribution, technology appears to be providing urban core areas with some niche functions.

The goods sector is particularly important for urban economies because the jobs often more closely match the skills of residents. The migration of manual labor jobs—whether in manufacturing or in service sectors such as transportation and wholesaling—has meant that most are located in the suburbs or smaller metros. This chapter examines how technological change has affected the location of three industries: freight transportation, wholesale trade, and manufacturing (see table 6-1).

**TABLE 6-1: Employment in Manufacturing, Transportation and Distribution (Employment in thousands)**

| | 1994 |
|---|---|
| Manufacturing | 18,472 |
| Railroads | 241 |
| Trucking | 1,564 |
| Courier service | 285 |
| Water transport | 167 |
| ■ Marine cargo handling | 54 |
| ■ Other | 113 |
| Air Cargo | 202 |
| ■ Air couriers | 108 |
| ■ Other carriers | 94 |
| Freight services | 171 |
| Total freight transport | 2,389 |
| Public warehousing | 127 |
| Wholesale trade | 6,229 |

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, *Employment and Earnings,* July 1995; and DR1/McGraw Hill, U.S. *Freight Transportation Forecast to 2003* (Alexandria, VA: American Trucking Association Foundation, April 1995).

## FREIGHT TRANSPORTATION[1]

Since colonial times, American cities, as centers of trade and transportation, have been central to the nation's economy. From New York in the age of the Erie Canal and the clipper ships, to Chicago and Kansas City in the railroad age, to the rise of Los Angeles and Seattle as centers of Pacific Rim trade, cities have been made and remade by changes in patterns of trade and in the technologies of transport. The next decade will be no exception, though it may not witness changes as dramatic as the birth of the trans-Atlantic jet or the beginning of the container revolution. Nevertheless, technological innovations will continue to affect the location of freight transportation, as well as the number and character of employment opportunities in America's cities.

Freight transportation consists of three main activities: 1) loading and unloading transportation vehicles at docks, ports, depots, and airports; 2) transporting the goods in vehicles (ships, rail, truck, airplane); and 3) freight services (e.g., freight forwarders). Historically, employment in all three areas tended to be located in urban areas, primarily because the infrastructure, particularly of ports and rail yards, and later airports, was there. Moreover, freight was also dispersed regionally, with most major coastal (ocean and inland) metros having their own ports, most metros having their own airports, and a large number of cities having truck and rail depots and transfer points. New technologies in freight have changed and will continue to change the spatial location of freight activities, particularly unloading and loading, both within metropolitan areas and between regions.

Within metropolitan areas, changes in the technologies of goods movement and distribution have shifted these activities from central city locations to the periphery, driven by considerations of cost, access, and land availability. This trend is likely to continue, for several reasons. First, as transport vehicles and handling equipment become larger and more capital intensive, facilities need larger and cheaper parcels of land. Second, traffic congestion and infrastructure restrictions limit the ability of many of the larger trucks and trains to enter core cities, or make it more difficult to regulate their access.

Competition for freight transportation and distribution is expected to intensify between regions. In part, this is due to increasing concentration and consolidation of shipping and of rail and air freight, as new information technologies allow control and scheduling from centralized locations, and as freight infrastructure becomes more capital intensive. Increasing capital intensity means a

[1] This section is based on a report prepared for the Office of Technology Assessment on freight transportation. Hugh O'Neill. "The Impact of Technological Change on the Location of the Freight Transportation Industry" (New York, NY: Appleseed, July 1995).

smaller number of more advanced facilities can handle larger throughputs more economically. Widespread deregulation of freight transportation has also increased competition and contributed to the spatial reordering of the industry.[2]

The days are gone when all that was needed to gain a freight job was a strong back and a willingness to work hard. With the adoption of more expensive and complex equipment, large numbers of lower-skilled urban workers can no longer easily be employed in freight handling. Moreover, future advances in technology are likely to require even higher skill levels.

## Shipping and Ports

There are four main technological trends in shipping: increased containerization, larger ships, more advanced port infrastructure, and application of information technology to tracking goods movement. The development of the container was a major change.[3] Even though containerization is already widely used, the range of products shipped through containerization is expected to grow as container technology is adapted to handling a wider variety of goods. Container ships are expected to increase in size as shipping companies seek to realize the economies of scale that containers make possible. The first generation of container ships typically carried 600 to 800 boxes; by the late 1970s, ships carrying more than 2,000 TEUs (20-foot equivalent units) were common. By 1990, ships with a capacity of 4,000 TEUs were plying the world's major trade routes, and some analysts expect that the cost-per-ton-mile of shipping containers in 5,000 TEU vessels will fall to levels comparable to that of bulk shipping. In addition, shipping companies and terminal operators now use computerized vessel stowage and terminal layout programs to plan the loading and unloading of cargo. Computerized preparation and processing of cargo release documents, in some cases using voice recognition systems, helps speed the movement of trucks into the terminal and back out again. These trends are concentrating shipping in even fewer ports, and encouraging the location of newer port facilities away from urban cores.

### *Port Consolidation*

Prior to the container revolution, central-city ports along the Atlantic, Gulf and Pacific coasts and, to a lesser extent on the Great Lakes, handled most of the nation's cargo trade. Their proximity to major markets minimized the need for inland transportation. Steamship lines usually called at ports in all the major markets, since moving the cargo by sea was usually easier and cheaper than unloading and repacking it for shipment by land.

With the advent of containerization, the shipping industry's requirements changed dramatically. Ports that handled smaller cargo volumes often found it difficult to finance the large up-front investment required to handle containers. As the shift from break-bulk carriage to containerization took hold, older, smaller ports on the East and West coasts lost traffic to new container ports in places such as Port Newark/Elizabeth, New Jersey, Oakland, Los Angeles and Long Beach. Containerization also affected the balance of trade between eastern and western ports. It was only with the advent of containers that true intermodal movement—relatively easy movement of boxes from ships to rail, and then to trucks for final delivery—became possible. The introduction of doublestack trains made "mini-landbridge" service—rail transport of containers from West Coast ports to East Coast markets—increasingly attractive. Minibridge routing was faster and allowed

[2] M. Kuby and N. Reid, "Technological Change and the Concentration of the U.S. General Cargo Port System: 1970-1988," *Economic Geography,* vol. 68, 1992, pp. 272-289.

[3] Shipping goods by container has meant a dramatic increase in goods handling productivity. As a result of containers, terminal handling costs declined from 55 percent of the cost of international shipping to 15 percent. Paul W. Chilcote, "The Containerization Story," in Mark J. Hershman, *Urban Ports and Harbor Management* (New York: Taylor & Francis, 1988), p. 130.

carriers to avoid the Northeast's higher-cost ports, which helped offset the higher line-haul cost of minibridge.

With stack trains carrying a rising flood of Asian goods to East Coast markets, East Coast ports—including New York, Philadelphia, and Baltimore—saw their share of the nation's maritime trade decline. Atlantic Coast ports handled 61 percent of the country's maritime trade in 1962; their share declined to 40 percent by 1987. Over the same period, the Pacific Coast ports' share rose from 13 to 46 percent.[4] Ports on the Gulf Coast also saw their share of maritime trade decline, as shippers and carriers often found it more cost-effective to serve this part of the country via rail connections to the major load centers. The rise of efficient intermodal service linking ships to trucks and rail also dealt a severe blow to maritime traffic on the St. Lawrence Seaway and the Great Lakes; by 1990, the Great Lakes ports combined share of America's maritime trade had declined to less than 1 percent.

For several reasons, the trend toward larger container ships will reinforce the concentration of maritime trade in a limited number of large "load center" ports. First, the economics of large ships favor limiting the number of port calls a vessel makes; fewer calls mean shorter transit times, better utilization, and more "turns" per ship. Larger ships, moreover, naturally favor ports that consistently generate enough traffic to keep them filled. The proliferation of large ships will also require substantial investments in the ports that serve them. Ships carrying 5,000 TEUs or more require drafts of 46 or even 50 feet. Ports that require extensive (and expensive) dredging, such as Newark/Elizabeth and Oakland, could be at a significant disadvantage relative to those whose harbors have greater natural depth (e.g., Seattle).

Since the value of lower ocean transit costs can be negated if containers wind up sitting on the ground for several days, shipping companies and terminal operators have an incentive to invest in equipment to expedite the movement of large volumes of containers—such as a new generation of faster, more powerful cranes. However, given the cost of such equipment, they also have an incentive to limit the number of locations in which its installation is necessary.

Finally, the relentless shift from break-bulk to containerized cargo will reinforce the trend toward concentration that is driven by larger ships. The decline of break-bulk will leave smaller ports with fewer opportunities to specialize in the handling of non-containerized niche cargoes such as automobiles, coffee, and cocoa.

### *Decrease in Central City Port Activities*

Container-ships need linear berths, backed up by broad expanses of open land, rather than old-fashioned finger piers. As new container facilities were developed on the periphery of major port cities, once-bustling inner-city piers declined. In some cities they were converted to other uses; in some they were left to decay.

No city offers a better example of the intra-regional impact of containerization than San Francisco. Dominant in West Coast maritime trade since the days of the Gold Rush, the city's economy was built around the cargo piers that framed its waterfront. But despite its maritime roots, San Francisco was slow to grasp the implications of the container revolution. While the Port of Oakland, its competitor across the bay, invested heavily in a new container terminal in the 1960s, San Francisco continued to invest in its break-bulk terminals. By 1979, Oakland was handling 10 times

[4] Scott Campbell, "Increasing Trade, Declining Port Cities: Port Containerization and the Regional Diffusion of Economic Benefits," Helzi Noponen, Julie Graham, Ann R. Markusen (eds.), *Trading Industries, Trading Regions: International Trade, American Industry and Regional Economic Development* (New York, NY: Guilford Press, 1993), p. 221.

the container volume handled in San Francisco. In the following decade, the value of Oakland's cargo traffic quadrupled, while that of San Francisco fell by 35 percent.[5]

Across the continent, developments in New York paralleled those in the Bay Area. The finger piers flanking Manhattan and the Brooklyn waterfront were ill-equipped to handle containers. Marine cargo traffic quickly shifted to newly built container terminals across the harbor, in Newark and Elizabeth, New Jersey.[6]

Increased containerization could put at risk some smaller urban core facilities that have managed to survive by handling break-bulk niche cargo. Since the mid-1980s, for example, New York's South Brooklyn Marine Terminal has had no business other than handling break-bulk shipments of cocoa. Loss of its cocoa trade would probably mean the end of maritime activity at South Brooklyn.

Perhaps most importantly, the transition to larger ships will favor those areas that offer direct access to rail service and to interstate highways. Because these ships are so large, and unloading and transport speed at the next stage is so critical, locations that cannot offer such service are likely to wither. Moreover, as discussed below, the rise of double-stack trains serving ports means that cities served by a single rail line with clearances too low to accommodate double-stack trains will suffer. Similarly, locations with poor highway access will also lose market share. At least a few older cities are likely to lose the last vestiges of their role as working cargo ports.

## Air Cargo and Airports

Just as technological change redefined the geography of the maritime industry, so has it contributed to a redistribution of air cargo activity. In this case, however, the result has been to disperse air cargo activity across a larger number of hubs and gateways, rather than to concentrate it. This dispersion has been fueled by the significant growth in air cargo itself, in part because of the rapid emergence of integrated all-cargo carriers after Congress deregulated the air cargo industry in 1977. By 1987, a half-dozen integrated carriers—Federal Express, UPS, Emery, Airborne, Burlington, and CF Air—had carved out a powerful position in the domestic air cargo business. The volume of cargo they handled grew by more than 400 percent in just a decade; their combined employment grew six-fold. Their combined fleet grew from 59 jets in 1977 (most of them small) to 402 a dozen years later (two-thirds of them 727's and DC-8's).

Information technology has been essential to the rise of the integrated air cargo carriers, and in particular to the growth of small package express services. The rapid delivery and high reliability these companies offer would be impossible without aggressive use of technology throughout their operations. The use of sophisticated information systems to manage the delivery of packages "end to end" led to the rise of integrated carriers such as United Parcel Service and Federal Express. UPS, for example, pioneered the use of "delivery information access devices" or DIADs—hand-held computers that allow drivers to input information about a shipment into the company's computer system at the point of pick-up or delivery. In addition, bar-coding has made it possible for the express carriers to automate some of the sorting that occurs at their primary and secondary hubs. It also allows them to track the movement of packages through their networks, and to share this information with their customers.

### *Regional Patterns*

Just as with other modes of transport, the increasing importance of air cargo has contributed to the emergence of such new centers of national and international commerce as Memphis, Miami, and Louisville (see table 6-2). Initially, all of the integrated carriers pursued a similar strategy—es-

[5] Ibid.

[6] B. Warf and L. Kleyn, "Competitive Status of U.S. Ports in the Mid-1980s," *Maritime Policy and Management*, vol. 16, 1989, pp. 157-172.

**TABLE 6-2: Integrated Air Cargo Carriers' Primary Hubs, 1987**

| | |
|---|---|
| Federal Express | Memphis, Term. |
| United Parcel Service | Louisville, Ken. |
| Emery-Purolator | Dayton, Ohio |
| Airborne Express | Wilmington, Ohio |
| Burlington Express | Ft Wayne, Ind. |
| CF Air | Indianapolis, Ind. |

SOURCE Office of Technology Assessment, 1995

tablishing hub-and-spoke systems for collection and distribution of packages, and making intensive use of information and communications technology to manage the flow of cargo in real time. All of them chose airports in or near the Ohio Valley and the Mid-South for their primary hubbing operations. Hubbing out of this region was efficient because its central location minimized the distance to most of America's people and businesses. Moreover, the cost of doing business in this region was considerably lower than it was in older air cargo centers such as New York, Chicago, and Los Angeles.[7] Most of these sites also offered access to the large work force required to support the integrated carriers' labor-intensive hubbing operations. The number of people UPS employs in its Louisville hubbing operations (about 13,000) is greater than the number of active longshoremen at all East Coast ports combined.

The growth of the two largest integrated carriers was so rapid, however, that by the mid- 1980s it was becoming clear they could not continue to channel nearly all their air traffic through Memphis and Louisville. The next step in the evolution of the system was a series of regional hubs. Federal Express established regional operations in Oakland, Indianapolis, and Newark, New Jersey; UPS, in Philadelphia and Ontario, California.

Just as advances in information technology have made possible the integrated carriers' complex hubbing operations—as well as the high-speed, highly reliable service immortalized in FedEx's tag line about "absolutely, positively" getting there overnight-so is information technology making possible a network of regional hubs. The ability to maintain central control over information-and the ability to make transactions appear seamless to customers, regardless of how they are routed—"is a prerequisite for the decentralization of operations. Advances in information technology make it possible for carriers, transportation managers, and shippers to centralize control of information, even as they decentralize operations.

Even with rapid expansion of regional hubs, air cargo operations have remained in metropolitan areas largely because the major airports handling passenger traffic are there. However, recently there has been increased interest in all-cargo airports. Such airports, in theory, would not have to be located in high-cost metropolitan locations. For example, the state of North Carolina has plans for a 15,000-acre complex combining an all-cargo airport and an industrial park, called Global Transpark, to be located in Kinston, a rural community in the state's economically distressed eastern region.

However, the concept of all-cargo airports has generally met with considerable skepticism in the air cargo industry, particularly proposals to locate new cargo airports in rural areas that do not generate any substantial air cargo of their own.[8] In 1991 about 50 percent of all cargo was carried in the bellies of passenger planes; and Boeing's annual aviation forecast projects this will increase to 58 percent by 2005. Relatively few cities or regions generate enough freighter traffic to sustain a separate facility. Moreover, airlines that provide both belly and freighter service-such as KLM and

[7] Peter Spaulding, "Reinventing the Air Cargo Wheel," *Portfolio,* Autumn, 1988, pp. 21-22.

[8] Considerations such as these led the FAA in 1991 to conclude that: " ....cargo will remain concentrated at very busy airports near major population centers where there is ample capacity available to shippers in the baggage holds of airliners.... Efforts to develop regional air cargo airports at other locations will involve considerable expense and financial risk." Department of Transportation, Federal Aviation Administration, *A Feasibility Study of Regional Air-Cargo Airports,* August 1991, p. 7.

Lufthansa—much prefer to have the two types of flights serviced by the same cargo terminal facilities, rather than duplicating facilities at separate passenger and cargo airports. And even all-cargo carriers such as Federal Express have a strong incentive to share basic airport infrastructure such as runways, roadways, and utilities with passenger airlines. The fact that most cargo activity occurs at late-night and early-morning hours, when passenger traffic is light, reinforces the logic of such sharing. Finally, cargo terminals at smaller airports may not have the volume of traffic needed to justify investment in complex automated systems.

Nevertheless, the recent success of Rickenbacker International Airport in Columbus, Ohio, and the beginnings of air cargo service at Alliance Airport in Fort Worth, suggest that cargo airports can work in some circumstances. Perhaps the most important is that the region the facility will serve already have a substantial traffic base, or at least be well-positioned to generate new traffic; these regions are usually larger and mid-size metropolitan areas.

### *Decentralization to Outlying Airports within Metropolitan Areas*

Metropolitan airports have become major centers of goods movement and distribution, but these activities generally takes place either at outlying locations within the central city, or in the outer suburbs. In metropolitan areas that have both older, smaller downtown airports and larger, newer (that is, post-World War II) airports farther out, air cargo and related distribution activity tend to be concentrated at the larger facilities—at Kennedy rather than LaGuardia, Dulles rather than National, O'Hare rather than Midway, Dallas-Fort Worth rather than Love Field. Newer airports, such as Alliance and Denver, are even farther from the urban core.

Moreover, in some cases the growth of cargo handling and distribution at these airports has attracted support-service businesses, such as freight forwarding and customs brokerage, that had previously been concentrated in downtown areas. In 1970, 79 percent of all employment in this industry in the New York metropolitan area was concentrated in Manhattan, but by 1986 Manhattan's share had declined to 31 percent. Nearly half of the region's freight-forwarding and customs brokerage jobs were located in the area around Kennedy Airport, in Queens and Nassau counties.[9] Chicago has seen a similar migration from downtown to suburban areas near O'Hare.

## Railroads

Although the major railroads will continue to make investments to increase the capacity of older intermodal terminals in or near central cities, a substantial share of the growth in longhaul intermodal traffic could be shifted to very large terminals built on greenfield sites on the fringe of major metropolitan areas. There are a number of innovations in rail service that are contributing to this decentralization.

First, though most train cars have not increased in size, they can haul more freight, largely because of double-stack container trains—trains that haul containers on specially designed rail cars that are slung lower than conventional cars and permit stacking of one container atop another.[10]

In addition, in a continuing effort to compete with conventional trucking services, railroads and intermodal companies are developing technologies aimed at making rail intermodal service more competitive at distances under 800 miles. A number of innovations reducing the time spent in

[9] Cathy Lanier, "The Nature of Trade-Related Services in the New York-New Jersey Region and the Influences on Their Location," Port Authority of New York and New Jersey, October 1990, p. 21.

[10] Double-stack service has grown rapidly since its introduction just over a decade ago. In April 1984, American President Companies started the first regular service, with just one train per week from Los Angeles to Chicago. By early 1995, about 250 double-stack trains per week were linking 86 metropolitan areas in the U.S., Canada and Mexico. Gerhardt Muller, *Intermodal Freight Transportation*, 3rd edition (Landsdowne, VA: Eno Transportation Foundation/Intermodal Association of North America, 1995), p.71.

**BOX 6-1: Information Technology and Railroad Operation Location**

Burlington Northern opened the James J. Hill Center, located on a 350-acre campus in Fort Worth, Texas, in April 1995. The new complex, which will ultimately employ about 870 people, is replacing seven regional dispatch centers that had previously managed the flow of traffic over BN's 22,000-mile network,

At its heart is a single 45,000-square-foot room, dominated by nine 18-by-24-foot screens, on which are displayed constantly changing real-time maps of the railroad's operations. They show where trains are, whether they are on-time, and weather conditions throughout the system. Individual dispatchers monitor train operations both on computer screens and by voice contact with train crews; a dispatcher in Fort Worth can type instructions into the system that will result in a switch being thrown a thousand miles away. Other specialists watch over BN's signaling systems, keep track of power consumption, and manage the deployment of personnel.

Burlington Northern planned the Hill Center with plenty of room for expansion. The railroad is now considering centralizing its marketing operations in the same location. '

[1] Jack Burke, "BN Inaugurates Network Operations Center," *Traffic World,* May 1, 1995, pp. 36-37

transferring cargo from one mode to another have helped spur the growth of intermodal traffic. Several equipment manufacturers have developed vehicles that can travel both on rails and on the highway. The only version that has seen any extensive commercial use to date is called the RoadRailer. It is, in effect, a highway trailer to which a specially designed set of rail wheels can be attached.

Rail operations have also benefited greatly from the development of real-time information systems that monitor the movement of equipment, deploy it more efficiently, and keep track of its performance. Today, all of the major railroads manage their operations through automated train control systems, or ATCS. These systems are often managed from a single nerve center. The newest of these is Burlington Northern's operations center in Fort Worth, opened in April 1995 (see box 6-l).

### *Decentralization of Operations*

After several years of sustained growth in long-haul intermodal traffic, and with growth expected to continue during the next decade, many of the nation's railroads are scrambling to increase the capacity of intermodal terminals in major metropolitan areas. In some cases, this has meant modernization and expansion of older rail yards located in or near the central city. CSX Intermodal, for example, is now expanding its terminal in Little Ferry, New Jersey—less than 10 miles from midtown Manhattan—by about 80 percent.[11] Conrail has sought to speed the flow of traffic through its South Kearney, New Jersey, terminal-the busiest intermodal rail facility on the East Coast—by expanding its gate complex and making more extensive use of automation. 12

However, several carriers have chosen a different strategy—very large intermodal terminals at

[11] "speed at the Tracks," *Via,* Port of New York-New Jersey, March/April 1995, p. 27.

[12] John H. Perser, "Intermoal Terminals of the Future will Offer Myriad of Choices, Demand Careful planning," Traffic World, April 18, 1994, p. 37.

greenfield sites on the periphery of major metropolitan areas. In 1994, the Santa Fe Railway opened a 575-acre terminal near Alliance Airport, on the outskirts of Fort Worth. The terminal has three tracks, each 6,000 feet long, with truck lanes in between; Santa Fe officials say the terminal has a capacity of 300,000 container lifts per year. The new facility replaces three smaller Santa Fe yards in Dallas and Fort Worth. Santa Fe has also built a new 269-acre terminal in Willow Springs, Illinois, to relieve congestion at its Corwith Yard in Chicago; and Norfolk Southern is developing a new 800-acre terminal west of Atlanta.

Although there is still considerable room to increase the capacity of older intermodal terminals by speeding the flow of traffic, greenfield sites could prove increasingly attractive as the volume of long-haul traffic rises. New yards on such sites can be designed from scratch to maximize the efficiency of intermodal operations much more easily than retooling a yard originally designed for box cars. Long parallel tracks such as those at Santa Fe's Alliance facility make it possible to work several mile-long double-stack trains simultaneously without breaking them down. Roadways and terminal gates can be designed to move trucks in and out more quickly; and outlying sites often permit truckers to avoid the street and highway congestion that characterizes the metropolitan core. Finally, in some cities it is difficult to move double-stack trains in and out of rail yards, due to low bridge heights.

## Trucking

One of the main changes in trucking has been the increase in the size of trucks. In 1984, most new trailers manufactured in the United States were 48 feet long; only about 1 percent were longer. By the early 1990s, the most common length for new trailers was 53 feet.[13] Fourteen states had enacted legislation allowing 57-foot trailers on some highways. The width of trailers permitted on the interstate system was also increased from 96 to 108 inches.

### *Decentralization of Trucking*

The past several decades have seen a shift in the trucking industry away from the city center. This trend reflects a number of other changes that have occurred in the economy of metropolitan areas. In port cities, for example, drayage companies have tended to follow maritime activity to new container facilities away from the downtown waterfront. The shift of manufacturing away from central cities has also led to a shift in trucking, as firms followed their industrial customers to outlying areas. Ready access to interstate highways has also been a factor in truckers' location choices. Land costs are also important, particularly for less-than-truckload carriers, who need terminals for breaking down and consolidating shipments.

The trend toward larger trucks will further erode the already-tenuous position of many older cities as regional or national distribution centers. Bridges, tunnels and arterial highways in these cities were in many cases not designed to accommodate trailers as large as those in use today, let alone even larger vehicles. Much of New York City, for example, is already off-limits to 102-inch-wide trailers; other cities, including Philadelphia and Boston, also strictly limit access by large trucks. In many cases, truck shipments bound for New York City are delivered to terminals in northern New Jersey, then transferred across the Hudson in smaller "straight trucks."

## Urban Core Freight Niches

Although the trend is for continued dispersion of freight activity to lower-cost metros and to outlying areas within metros, there are three areas where urban cores may continue to play a role. First, while many freight services, particularly air freight, have moved to the suburbs, other freight services have remained downtown. In part, this is because of the proximity to other firms in down-

[13] Gerhardt Muller, op. cit., footnote 10.

town locations. Second, many freight terminals have sunk costs of infrastructure in urban areas, making it expensive to move. For example, Conrail has just introduced a new generation of container stackers—the world's largest—at its Croxton Yards facility in New Jersey, just a few miles west of midtown Manhattan. Such large-scale physical investments exert inertia to stay in these locations. Similarly, large ports have invested in container cranes, electronic processing systems, and land-based infrastructure. In addition, in some cities where the large freight airport is still close to the urban core, these cites continue to provide jobs. For example, New York's Kennedy airport, with a total land area of 5,000 acres, has plenty of space available on which to develop air cargo facilities.

Third, just as specialty and flexible manufacturers appear to have competitive niches in urban cores, so too do specialty freight carriers. As a result, the next decade could see smaller facilities in or near central cities that are designed to handle short-haul and specialty cargo. In shipping, a new generation of faster, smaller vessels now being developed might complement very large container ships by providing feeder service from smaller ports to large load centers. In addition, because they need not aggregate the massive volume of cargo required for economical operation of very large container-ships, smaller, faster vessels could operate more effectively in "point-to-point" service. Whether smaller, faster vessels—such as those now being developed by FastShip Atlantic—can succeed in capturing a significant share of America's maritime trade remains to be seen.

In intermodal rail and truck freight, the short-haul economics will make sense only if the truck trips at either end are short as well. This argues for keeping terminals as close as possible to customers, and if short-haul service attracts enough volume to justify them, for multiple terminals. For example, the "Iron Highway" system that CSX Intermodal will begin testing this summer between Chicago and Detroit will use an existing 10-acre yard in Chicago.[14] Because they provide a roll-on, roll-off system, Iron Highway terminals will not need elaborate and expensive lifting equipment; they will, however, emphasize moving trailers in and out quickly. Whether new forms of intermodal service can be truly competitive with trucks at distances of 300 to 500 miles remains to be seen. Even if it succeeds, short-haul intermodal is likely to remain a niche service, targeting specific markets. But it could provide some small-scale opportunities in central cities—and could offer central-city shippers some new opportunities for moving their goods.

Finally, not all types of trucking have declined in central cities. In New York, for example, even as trucking companies serving the city's shrinking manufacturing base were declining, courier services linked to the city's services sector were expanding. The high value of the goods carried by these companies, and the premium placed on timely delivery, make it easier to justify the high cost of New York City terminal space. UPS, for example, has several terminals in the city, including one on the lower west side of Manhattan.

## WHOLESALE TRADE AND DISTRIBUTION[15]

The spatial distribution of wholesale employment has remained decidedly metropolitan over the last 25 years, with the share of employment in metro areas hovering around 88 percent (compared to 82 percent for all U.S. employment). However, like freight transportation, goods distribution is undergoing technological change that could lead to relocation or consolidation of facilities in

[14] The Iron Highway is a train of articulated rail cars that, when linked, form one continuous surface. This "highway" makes it possible for conventional tractors to pull trailers directly on and off the train, using sliding ramps.

[15] This section is based on a report prepared for the Office of Technology Assessment on wholesale trade and distribution. Amy Glasmeier and Jeff Kibler, "Turning Stocks into Flows: The Effects of Technological Change and Transportation Deregulation on the Location of Wholesale Employment in the U.S.," July 1995.

lower-cost areas away from urban cores. Information and telecommunications capabilities allow firms to deliver goods much faster than before, allowing in turn a consolidation of distribution facilities. Regional competition for distribution business is likely to intensify, as the trend toward consolidation puts this activity in play. Moreover, as technologies enable faster and more responsive delivery and as distribution facilities get larger, they will tend to locate outside the core of large metropolitan areas.

## Technological Change

The wholesale trade industry is in the midst of a technological revolution that is speeding up the flow of goods and moving the wholesale industry from a system of stocked warehouses close to population and industry centers, to one of fewer larger-scale distribution centers serving large geographic areas. Much of this change is made possible by information technology, which allows goods to be moved quickly to where they are needed. There are several important technologies.

Electronic data interchange (EDI), or computer-to-computer information interchange, significantly improves the amount, timeliness, and quality of data transfer. Companies communicate order shipment information with vendors, suppliers, transportation carriers, and customers.[16] EDI can compress time for the wholesaler and facilitate a more flexible distribution system. Moreover, through EDI, demand can be communicated in real time from the point of need to the point of supply, enabling wholesalers, distributors, and manufacturers to react more quickly to demand. Use of EDI in public/contract warehouses is expected to double by the year 2000.[17]

If EDI links the transactions of firms, bar coding is how information is exchanged. Bar coding is improving logistics and inventory control by improving data collection accuracy, reducing receiving operations time and data collection labor, and integrating data collection with other areas.[18] Companies can assign items more quickly to the warehouse, warehouse personnel can prepare orders more rapidly, deliveries are more accurate and timely, and there are fewer claims to process. A warehouse receiving area equipped with a bar-code system can check in 300 cartons per hour, compared to 120 cartons per hour manually.[19] Future innovations in bar coding will allow greater amounts of information to be stored in ever smaller spaces and will dramatically reduce administrative and order preparation time. The use of bar coding and scanning systems is expected to rise from 15 to 81 percent by the year 2000.[20]

A third major area of technological change is mechanization of distribution facilities, commonly through a conveyor system. Warehouse automation is expected to climb from 17.8 percent in 1990 to 54.7 percent by the year 2000.[21]

These technological changes have facilitated the development of new practices, including the development of "just-in-time" (JIT) delivery systems where goods are delivered to their destination at the time and in the quantities that they are needed. Just-in-time systems demand that suppliers and transport providers deliver materials fast,

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[16] John J. Coyle, Edward J. Bardi, and John C. Langley, *The Management of Business Logistics,* 5th edition (St. Paul, MN: West Publishing Company, 1992).

[17] Arthur Anderson and Company, *Facing the Forces of Change 2000*: *The New Realities in Wholesale Distribution.* (Washington, DC: Distribution Research and Education Foundation, 1994), 244 pp.

[18] A bar coding is a series of black and white bars of varying width, whose sequence represents letters or numbers. This sequence is a code that computer-controlled electronic scanners can translate into information such as shipment origin and destination, product type, and price.

[19] Coyle, Bardi, and Langley, op. cit., footnote 16.

[20] R.V. Delaney and B. La Londe, *Trends in Warehousing Costs, Management, and Strategy* (Oak Brook, IL: Warehousing Education and Research Council, 1993).

[21] Arthur Anderson and Company, op. cit., footnote 17.

frequently, and with a high degree of reliability. Right behind JIT, in the retail apparel industries, came Quick Response (QR) where the manufacturer and retailer share point-of-sale data from the retailer's cash register to coordinate the flow of inventory from plant to store. For example, K-Mart has adopted a Quick Response program with its vendors. The percentage of goods shipped using QR/JIT is expected to increase almost threefold, from 14.4 percent in 1994 to 39 percent in the year 2000.[22]

Another new approach is "cross-docking," a practice pioneered by Wal-Mart. In cross-docking, shipments of goods arriving at a warehouse or distribution center are not put into storage at all, but are instead immediately broken down and reorganized for re-shipment to other destinations. A warehouse operated by an apparel retailer, for example, might during the course of single morning receive shipments from a dozen manufacturers, break them down and recombine them for distribution to a hundred stores before the end of the day. Today, only the most sophisticated distribution centers have such systems; during the next decade, they will become increasingly common.

## Regional Concentration of Distribution Functions

These new technologies and practices allow wholesale distributors to serve several urban markets from a centralized distribution facility. New information technologies and practices allow products to be delivered to the customer much more quickly than before. Moreover, the declining real cost, increased reliability, and increased speed of many forms of transportation (particularly integrated, all-air cargo operations), mean that distributors do not need to be close to the final customer. These changes are making it possible for distributors to remain functionally close to customers, without being geographically close. Finally, automation is leading to consolidation since facilities must be larger to support dedicated automated equipment and achieve economies of scale.[23] For example, it is much easier and less expensive to operate sophisticated warehouse systems in three locations than in 12. By consolidating distribution facilities, companies cut costs and improve quality control, without sacrificing customer responsiveness.[24]

Over the past decade, firms in many industries have consolidated their logistics function. Fifteen years ago, most consumer-packaged goods companies operated 10 to 15 stocking locations. Today, most have consolidated operations in five to seven locations (see table 6-3). National pharmaceutical and medical products distributors, for example, previously operated up to 90 locations; today, the three major distributors have between 45 and 48 facilities, with plans to consolidate further to between 30 and 35 locations.

Some firms have concentrated their operations in just a few (or even just one) large distribution center. Nike, for example, ships shoes and apparel to retailers throughout the country through three distribution centers—a 400,000-square-foot facility (for shoes) near its Beaverton, Oregon, headquarters, and two in Memphis (with a combined total of 1.4 million square feet of space) handling apparel and shoes, respectively. Distribution operations for The Limited, a major apparel retailer, are even more centralized, with more than 3,500 stores nationwide supplied from a single, massive distribution center near its Columbus, Ohio, headquarters. In addition to its proximity to headquarters, Columbus offered a central location, frequent double-stack intermodal service from the West Coast, air cargo facilities,

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[22] Ibid.

[23] W. Copacino, "Back to Market-Based Warehousing," *Traffic Management*, vol. 32, No. 10, October 1993, p. 29.

[24] Robin Pano, "Pull Out the Stops in Your Network," *Transportation and Distribution*, August 1994, pp. 38-40.

TABLE 6–3: Recent Examples of Distribution Consolidation

| Company | Business | Consolidation |
|---|---|---|
| AT&T | Wireless communications equipment | Consolidated international distribution from Columbus, Denver and Oklahoma City in a new 250,000-square-foot facility in Columbus. |
| Canon | Copiers, fax machines | Consolidated five regional warehouses into one national distribution center in Memphis in 1993. |
| Nike | Athletic Shoes and Apparel | Consolidating 31 distribution centers into a single center in Lakdaal, Belgium. |
| Dress Barn | Apparel retailing | Moved from four warehouses in New Jersey and Connecticut into a new 51O,OOO-square-foot distribution center in Suffern, NY. |

SOURCE Office of Technology Assessment, 1995.

and easy access to the interstate highway network.[25]

For U.S. cities and regions, this change in distribution patterns has profound implications. If facilities no longer have to be physically close to the customer to be functionally close, companies can be much more selective about the locations from which they distribute. Distribution increasingly becomes an "export" function--one for which regions must compete—rather than a component of each region's local service sector.

What factors will drive regional competition for distribution activity? The variables taken into account in classical warehouse site selection analyses—proximity to markets and to sources of goods, land, and labor costs—will still be relevant.[26] But as firms more strongly emphasize cycle-time compression and reliability of response, other factors are likely to become more important. For companies that ship many of their products on a just-in-time basis, proximity to an air express regional hub may be essential; others may require easy access to a double-stack intermodal terminal. Winners in this competition are likely to be regions that offer the best combination of access to large markets, frequent and extensive multimodal transportation service, good local access to transportation hubs, a first-class telecommunications network, a high-quality labor force, and competitive costs—and that have a coherent strategy for developing distribution business.

Increasingly, these are likely to be in smaller or mid-sized metropolitan areas in the 100,000 to 250,000 population range. For example, Sioux Falls, South Dakota, is a small metropolitan area with a growing cluster of distribution operations, including those of Nordic-Track and Gateway 2000. The cost of operating a 350,000-square-foot, 225-employee distribution center is $2 million to $2.5 million less in Sioux Falls than in metropolitan Minneapolis or Chicago, even after the higher cost of shipping into and out of Sioux Falls is taken into account.[27]

## ■ The Increase of Distribution Functions in Peripheral Areas

During the past two decades, most of the growth in warehousing and distribution has occurred on the periphery of America's metropolitan areas. For several reasons, this trend is likely to continue, driven by the technologies and operational prac-

[25] Apogee Research, Inc. Case Studies of the Link Between Transportation and Economic Productivity (Bethesda, MD: January 1991), p. 34.

[26] Coyle, Bardii and Langley, op. Cit., footnote 16, p. 429.

[27] Tom Andel, "Market Reach Grabs Shippers," Transportation and Distribution, June 1995, p. 54.

tices described above, combined with increasing consolidation.

First, information technology and new practices reduce order transmittal and processing time and provide a larger window of transportation time, allowing facilities to locate in peripheral areas of metros with lower land and labor coststwo large components of warehouse costs.

Second, traditional wholesaling buildings in the urban core are often not suitable for automation, regardless of cost. Thus, one major effect automation may have on the wholesale industry is the abandonment of many older, multi-level, urban warehouses, since in most cases it is more cost-efficient to build a new facility. Also, automation, along with EDI and bar-coding technology, is used in most cross-docking facilities, which are structured very differently from traditional urban warehouses.

The ideal modern warehouse is designed to maximize efficient material handling and storage. These structures are single-level facilities with high ceilings. The high ceilings, along with racking systems, provide efficient upward storage. The internal layout is designed for one-way flow of product, with the inbound and outbound functions at opposite ends of the building.

In general, older urban warehousing structures are multi-leveled and have lower ceilings than modern facilities. Many in the industry believe that, in most cases, renovating older urban warehouses is not cost-effective because of the extreme structural changes required for these buildings to be operationally efficient.

Even with cross-docking, which can be implemented in lower volume and smaller facilities, there are likely to be problems converting older urban warehouses. An efficient cross-docking operation requires a structure with a number of shipping and receiving doors. In addition, internally, the building must be designed to allow the unidirectional flow of product. Many urban structures have an inadequate number of dock doors, and are not designed for a flow-through system.

The increasing average size of warehouses and distribution facilities, driven by consolidation, leads to decentralization because larger parcels of land are needed. In central cities or close-in suburbs, especially in the more urbanized areas of the Northeast, it may be difficult to find suitable large sites. Even where sites are available that can support large, modern distribution facilities, high land costs provide a powerful incentive to locate on the metropolitan fringe.[28]

Finally, because facilities are being transformed into distribution hubs, a single-level, highly automated cross-docking facility is best located in areas of low congestion with access to major transportation routes. These are often in the outer suburbs. Moreover, the continuing evolution of the trucking industry will also work against older central cities as locations for distribution centers. Since most distribution facilities are at least partly dependent on long-haul trucking for both receipt and shipping of goods, their owners naturally want to take advantage of any measures that might reduce trucking costs. This means that locations offering unrestricted truck access will be more attractive than locations to which the largest trucks—whether as a result of regulatory restrictions or as a result of infrastructure limitations—do not have access. Companies planning to develop large distribution centers will thus tend to prefer sites with direct access to highways (usually interstates) on which very large vehicles—trailers more than 53 feet long, or more than 13.5 feet high, as well as doubles and triples—are permitted to operate.

However, just as with intermodal freight terminals, there may be opportunities to develop smaller distribution facilities serving more concentrated markets in central-city locations. Hospitals in some cities, for example, have moved to a "stockless purchasing system"—one of the

[28] Ann Strauss-Weider, "The Changing Face of Regional Warehousing," *Portfolio*, Summer 1989, p. 32.

more aggressive applications of just-in-time distribution. Very little material is kept on the premises; the hospital-supply contractor makes several deliveries to each hospital it serves during the course of a day. The contractor may "pick and pack" specific items not just for individual departments within a hospital, but even for specific closets and supply bins.[29] This system relieves hospitals of inventory and storage costs, and of the need to manage an internal distribution system. However, the need to make multiple deliveries each day, and the need to be able to respond quickly in emergencies, means that there are advantages to the distributor in being located close to the hospitals it serves. One of New York's leading medical supply companies, for example, now serves New York City hospitals from a distribution center in the South Bronx; and two other supply companies are now contemplating the establishment of similar facilities in the city. As more businesses and institutions implement just-in-time and direct-replenishment supply programs, opportunities to locate relatively small, specialized distribution centers in or near central cities should increase.

In addition, in some cases, however, ingenious designs can lead to innovative reuses of urban warehouses. For example, Space Technology, Inc. is renovating urban facilities to achieve functional warehouses. In Long Island, New York, the company is using a patented technology called the E-Z Riser to raise the roofs of urban structures. To solve the problem of lack of facilities for cross-docking and throughput distribution, some real estate entrepreneurs are using innovative marketing techniques that undertake feasibility studies and offer design plans for reuse of large vacant urban properties. Clark Properties, a St. Louis-based real estate company, is in the business of renovating urban industrial property. One such renovation was an abandoned General Motors plant. "This plant was transformed into the 160-acre Union Seventy Center, a self-contained industrial park with major warehousing and distribution operations. The Union Seventy Center represented a renovation of three million square feet of space. Clark Properties estimates that it will return 3,000 jobs to the St. Louis area. It already has attracted three major carriersJ.B. Hunt, Schneider National, and North American Van Linesall of which made Union Seventy Center their St. Louis terminal."[30] Large abandoned factories with good transportation access may provide an opportunity for some older central cities to attract some distribution jobs.

## MANUFACTURING

Much has been written about the decline of manufacturing in older regions and cities in the United States. Starting first in New England in the mid-1970s, and spreading next to the industrial Northeast and Midwest in the late 1970s and early 1980s, metropolitan areas increasingly faced the wholesale restructuring and decline of older mass production industries, including steel, autos, lumber and wood products, oil and gas, and textiles. In addition, much manufacturing production moved from the old urban environments of the Frostbelt to the new cities and suburbs of the Sunbelt; in many cases, manufacturing left America altogether, exported to low-wage developing nations.

There are a number of technological reasons for the decentralization and deconcentration of manufacturing employment.[31] First, improvements in transportation have aided decentralization. Much manufacturing originally located in cities because of accessibility to energy, ports, railroads, markets, and, via waterways and rail, raw materials. Modern shipping technology, commercial aviation, interstate highways, and large

[29] Apogee Research, Inc., *Case Studies of the Link Between Transportation and Economic Productivity* (Bethesda, MD, January 1991), p. 21.

[30] E. J. Muller, "Urban Logistics," *Distribution*, vol. 91, No. 4, April 1994, pp. 68-70.

[31] Manufacturing includes a wide range of diverse industries with different locational patterns. This chapter focuses largely on discrete goods producers (e.g,. automobiles, textiles, electrical equipment) and not on process industries (e.g., chemicals, petroleum, paper).

refrigerated trucks obviated industry's need to remain in the city, so that other factors, including labor and land costs, came into play in location decisions. In particular, the interstate highway system meant that manufacturers could choose from a larger selection of places. Also, as firm size grew and manufacturers were more likely to sell to many cities, the importance of the central city as the point of easiest access to the city market diminished.

Second, changes in production technology affected plant location. In the early and mid-part of this century, widespread electrification meant that factories could locate virtually anywhere in the United States and have access to electricity. Later, mass production technologies meant large plants with production laid out on one level. The old three- or four-story city plant was not appropriate to mid-20th century industrial production. For example, in the New York City region, factories built before 1922 averaged 1,040 square feet, increasing to 2,000 square feet between 1922 and 1945, and after the war to 4,550 square feet.[32]

In addition, as industries matured and reached the end of their product life cycle, manufacturing decentralized. According to product life cycle theory, products go through stages from innovation, to growth, to standardization.[33] In its early entrepreneurial and innovative stages, industry often requires design, engineering, inventive, and financial talents more likely found in the city. In the second stage of development, highly skilled urban workers with craft and technical know-how refine the product and begin production in small batches for small markets. But once production is standardized and mechanized and aimed at mass markets, a moderately skilled or even unskilled workforce can do the job. This last stage implies dispersal to where land, labor, and energy are less costly than in the city.[34] Moreover, as firms substituted capital for labor, more capital-intensive firms were able to secure needed labor in less populated areas.

Yet, for two reasons, technological change in manufacturing has not meant a movement away from metropolitan areas altogether. First, high-technology industries have concentrated more in urban areas, although largely in the suburbs. Second, technologically advanced enterprises are more likely to locate in urban areas, in part to be near suppliers, skilled workers, and other sources of innovation.

## High-Technology Industries

Employment in high-technology industries, such as electronic equipment makers, aircraft, semiconductors, telecommunications equipment, and instruments, has grown much faster than in low-technology industries. High-tech manufacturing is more concentrated in metropolitan areas than lower-tech industries.[35] In 1982, 88.6 percent of high-tech employment was located in metropolitan areas.[36] For example, Barkely found that high-technology manufacturing grew faster between 1975 and 1982 in metropolitan areas than in non-metro, and within metros, the suburban counties of large metropolitan areas grew the fastest.[37] Within large metropolitan areas, high-tech industries appear to be more suburbanized than low-tech industries (see table 3-5). Moreover,

[32] Robert Fishman, *Bourgeois Utopias: The Rise and Fall of Suburbia* ( New York: Basic Books, 1986), p. 196.

[33] U.S. Congress, Office of Technology Assessment, *Technology, Innovation, and Regional Economic Development,* OTA-STI-238 (Washington, DC: U.S. Government Printing Office, 1984).

[34] John Rees and J. Norton, "The Product Cycle and the Spatial Decentralization of Manufacturing," *Regional Studies*, vol. 13, 1979, pp. 141-151.

[35] OTA, *Technology, Innovation and Regional Economic Development,* op. cit., footnote 33.

[36] David L. Barkley, "The Decentralization of High-Technology Manufacturing to Nonmetroplitan Areas," *Growth and Change,* Winter, 1988.

[37] Ibid., p. 17.

innovative high-technology industries were even more likely to grow faster in metro than non-metro areas.[38]

## Flexible Production Manufacturing

In the last 15 years much has been written about computer-integrated manufacturing (CIM).[39] A central feature of all components of CIM is the integration of computer-based information technologies into the production system. There are a number of technological components involved: 1) design and engineering technologies, including computer-aided design/computer-aided manufacturing (CAD-CAM), including digital CAD; 2) fabrication machinery, including computer-numerically controlled machines and robots; 3) automated materials handling, including automated storage and retrieval systems and automatic guided vehicles; 4) automated sensors, in particular for inspections and testing; and 5) communications systems, including Local Area Network (LAN) systems to communicate within the plant and with suppliers and customers.[40] These technologies allow firms to produce in more flexible ways than standardized mass production. Computer-aided manufacturing helps firms achieve efficiencies normally associated with long, dedicated production runs, but with shorter production runs. This kind of production is well-suited to small innovative firms that are involved in dense supplier and cooperative networks.

Relative to firms using less advanced technologies, flexibly specialized firms are more likely to be in metropolitan areas.[41] There are a number of reasons for this. First, flexible technology systems depend on the availability of sophisticated design and engineering talent, which is often found within metropolitan regions. Moreover, these firms often need to be near customers. For example, one study of manufacturing found that the New York City region was more oriented to small and medium-sized firms capable of quick turnaround on customized products.[42] Second, as FMS systems are adopted, the ratio of fixed costs (e.g., machines, software programming) to variable (e.g., labor, power) increases. Because these firms compete less on cost and more on other factors, such as quality, innovation, and response time, they face fewer pressures to move production to lower-cost peripheral areas.[43]

Third, these firms often enter into cooperative arrangements with other producers or suppliers, and the density and proximity offered by metropolitan areas are ideal for the growth of such agglomeration economies. In many cases, small flexibly specialized firms cooperate in order to defray the costs of expansion and technological modernization, and to exchange technical and

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[38] Ibid, p. 20.

[39] For example, see John A. Alic, "Computer-Assisted Everything? Tools and Techniques for Design and Production," *Technological Forecasting and Social Change*, vol. 4, 1993, pp. 359-374.

[40] Timothy Dunne, *Technology Usage in U.S. Manufacturing Industries: New Evidence From the Survey of Manufacturers* (Washington, DC: Center for Economic Studies, Bureau of the Census, U.S. Department of Commerce , November 1991, CES 91-7).

[41] David L. Barkely and Sylvia Hinschberger, "Industrial Restructuring: Implications for the Decentralization of Manufacturing to Nonmetropolitan Areas," *Economic Development Quarterly*, vol. 6, No. 1, 1992; see also Allen J. Scott, "The New Southern California Economy: Pathways to Industrial Resurgence," *Economic Development Quarterly*, vol. 7, No. 3, August 1993, pp. 296-309.

[42] Telesis, Inc., *Strategic Audit of the NY/NJ Manufacturing Sector*, prepared for the Port Authority of New York and New Jersey, 1988, cited in Mitchell L. Moss, Hugh O'Neill, Timothy Bates, and John Kedeshian, *Made in New York* (New York, NY: Taubman Urban Research Center, New York University, 1995).

[43] Ramchandran Jaikumar, "Postindustrial Manufacturing," *Harvard Business Review*, November-December 1986, pp. 69-76.

market information. For example, textile and apparel manufacturing in Los Angeles and New York appear to thrive, in part because of close contact with designers that allows them to produce new designs rapidly.[44]

Finally, computer-integrated manufacturing (CIM) and other flexible technologies appear to reduce optimal facility size, allowing smaller sites to be profitably used.[45] The average manufacturing establishment declined from approximately 50 employees in 1977, to 42 in 1992.[46] This reduces land and building costs, reducing pressure to migrate to areas with lower cost land; thus, locating within the confines of urban factories and warehouses becomes more feasible.

Finally, in the case of companies pushing for flexibility, employees find themselves engaged in a wider range of frequently changing tasks, putting a greater premium on alertness and diligence, as well as continuing on the job learning.[47] As a result, firms choose to locate in metropolitan areas to be close to higher skilled workers.

## The Persistence of Urban Manufacturing and Its Future Prospects

Though new manufacturing process technologies based on information technologies helped slow the decentralization of manufacturing employment away from large, higher-cost metropolitan areas, it has not necessarily meant that manufacturing is staying in urban cores. In fact, high-tech manufacturing appears to be highly concentrated in suburban counties. However, technological change does open up the possibility of some urban manufacturing niches.

There are a number of reasons why some manufacturing remains in urban areas.[48] First, inertia; that is, many manufacturers in cores stay because they are already there, and moving is too expensive or bothersome. However, sooner or later, the owners of “inert” businesses retire or die, close their plants, and disperse their employees.

Second, some manufacturers, such as printing, food processing, construction materials, and arts/entertainment equipment are located in cities to serve local markets.[49] Similarly, recycling firms are on the increase in urban areas in order to be near supplies of consumer and business waste.[50] For example, in New York City, Pratt Industries, an Australian-owned company, has leased a 30-acre site on Staten Island and has recently announced that it intends to build a plant employing 400 people making linerboard and corrugated boxes. At $250 million, it is one of the largest manufacturing investments in New York City in several decades. The access to a reliable and concentrated supply of raw material (mixed waste paper) was a key factor in their location decision.

Third, manufacturing dependent upon rapidly changing designs or with need to be close to upscale customers may do well. The importance of design—one of the factors that plays a role in the persistence of manufacturing in New York—also appears to explain a modest revival of city

[44] David Friedman, “Getting Industry to Stick: Enhancing High Value-Added Production in California,” unpublished manuscript May 1992, p. 7.

[45] Jaikumar, op. cit., footnote 43.

[46] U.S. Department of Labor, Bureau of Labor Statistics, unpublished data.

[47] U.S. Congress, Office of Technology Assessment, *Worker Training: Competing in the New International Economy,* OTA-ITE-457 (Washington, DC; U.S. Government Printing Office, September 1990).

[48] Kenneth E. Poole and Caroline Samuels, “Manufacturing Trends in America’s Larger Cities,” in *Urban Manufacturing: Dilemma or Opportunity*? (Washington, D.C.: National Council for Urban Economic Development), pp. 21-28

[49] B.M. Nicholson, Ian Brinkley and Alan W. Evans, “The Role of the Inner City in the Development of Manufacturing Industry,” *Urban Studies,* vol. 18, 1981, pp. 57-71.

[50] Hugh O’Neill and Megan Sheehan, *Exploring Economic Development Opportunities in Recycling,* (New York, NY: Urban Research Center, New York University and Appleseed, August 1993).

manufacturing in the Great Lakes region and in industries like automobiles and steel that were once key urban manufacturing sectors. Two recent studies describe a process of "reindustrialization within deindustrialization" or manufacturing "reconcentration" in the old industrial Midwest.[51] Hicks argues that Japanese manufacturers who build plants in the Midwest may not locate in central cities, but nonetheless make use of design, toolmaking, and engineering skills to be found in the region's cities.[52] Similarly, textile manufacturing in Los Angeles was spawned by design requirements. Los Angeles garment manufacturers required two things: high-quality, well-designed textiles, and just-in-time production that could satisfy the demand for seasonal clothing changes and sophisticated fashion. These manufacturers provided a local market for textile specialists from around the world—Iran, Korea, Western and Eastern Europe, and the eastern United States—all of whom converged in Los Angeles in the mid-1970s.

Fourth, the need for close linkages to other firms, including service firms, may give some urban areas a competitive edge. Linkage to the service sector helps to explain the persistence of another industry—entertainment-related manufacturing—crucial to the Los Angeles economy. The movie and television industry in Los Angeles now consists of many small firms, linked together regionally with corporate distributors on one end, and a host of suppliers and sub-suppliers on the other end.[53]

Finally, cities provide a pool of workers, many often immigrants, willing to work at low-wage manufacturing jobs (e.g., clothing apparel, leather goods). There are two reasons why the informal economy in manufacturing is generally an urban phenomenon. First, it makes use of low-wage but often highly skilled immigrant labor (e.g., Dominicans trained to sew, Asian cooks, Mexican and Brazilian metalworkers), especially undocumented aliens, who are now readily found in large cities. Second, it is comprised of small businesses whose start-up costs, plant spatial needs, and function in the larger economy are well-suited to a densely populated city location.[54]

New York City, for example, exemplifies many of the elements that make for the persistence and perhaps for the vitality of urban manufacturing. New York has a number of firms that remain because of inertia—e.g., Farberware cookware, which has been in the same building in the South Bronx for more than 50 years. New York City's density also provides an internal market for some kinds of manufacturing such as customized food supply and commercial bakeries. New York's role as a center for arts and design spawns customized manufacturing that relies heavily on the design component, that can adapt to cyclical changes in fashion, and that produces for niche markets. This helps to explain why industries like fashion apparel, leather goods, fabricated metals, specialized and upscale furniture manufacture, cosmetics, crafts and manufacture attendant upon movie making, and specialized textiles are doing well in New York. New York's strong service sector likewise stimulates certain kinds of manufacturing such as commercial printing, paper-related products, construction materials, office furnishings, arts/entertainment equipment and supplies.[55]

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[51] Richard Florida, "The Economic Transformation of the Industrial Midwest," Draft Paper, Carnegie Mellon University, August 1994; and Donald A. Hicks, *Beyond Global: Innovation and Adjustment in U.S. Automobile Manufacturing* (Washington, D.C.: American Enterprise Institute, 1994).

[52] Hicks, ibid.

[53] Susan Christopherson and Michael Storper, "The Effects of Flexible Specialization on Industrial Politics and the Labor Market: The Motion Picture Industry," *Industrial and Labor Relations Review*, vol. 42, No. 3, April 1989, pp. 331-347.

[54] Saskia Sassen, "The Informal Economy," in John Mollenkopf and Manuel Castells (eds.) *Dual City: Restructuring New York* (New York, NY: Russell Sage Foundation, 1991), pp. 79-102.

[55] Mitchell Moss, op. cit., footnote 42.