Technological Innovation and the Trucking Industry:

Information Revolution and the Effect on the Work Process

Submitted to Journal of Labor Research

First submitted July 2, 2001

Revised August 14, 2001

Michael H. Belzer

Associate Professor

College of Urban, Labor, and Metropolitan Affairs

Wayne State University

Detroit, MI 48202

Phone: 313-577-1328

Fax: 313-577-8800

E-mail: Michael.H.Belzer@wayne.edu

and belzer@umich.edu

Acknowledgements: The University of Michigan Trucking Indusry Program, funded by the Alfred P. Sloan Foundation, provided funding for this research. Additional researchers who participated actively in data collection include Stephen V. Burks (University of Minnesota – Morris), Peter F. Swan (The Pennsylvania State University), and Margaret Shackell-Dowell (Notre Dame University).

I. Introduction

Trucking is a derived demand, labor-intensive industry with a traditional industrial relations climate; it has always been a highly competitive and cost-driven industry. In the union sector, industrial relations traditionally have been conflictual, although when the Teamsters were strong conflict was muted by their ability to control the process. Indeed, like the needle trades, motor carriers primarily were local operators and the fragmented industry structure allowed the union to regulate competition.

The trucking industry has experienced substantial change since 1980. Until the end of the 1970s trucking was a regulated utility — a service that people took for granted along with such services as telephones and electric power. Everyone was entitled to access to trucking services. Beginning in the late 1970s, an intellectual and policy change favoring economic deregulation gained ascendancy and that change spawned the competitive environment in which the industry currently operates. This intellectual and policy change has nearly swept away the "utility" concept for energy utilities as well, although California's recent energy crisis presents challenges to energy deregulation.

For trucking, the most significant changes that have occurred in the past two decades involve interstate deregulation in 1980 and intrastate deregulation in 1995. Deregulation actually began in 1977 with administrative changes begun below the legislative level in an effort to combat the inflation and stagnation that then gripped the nation. The Interstate Commerce Commission (ICC) began to loosen its controls on trucking operations, allowing more entry and supporting various policies that advantaged owner-operators and small carriers over common carriers.

I argue here and elsewhere that the term "deregulation" as a political term means representing a policy approach replacing institutional regulation with market regulation. Its use as a slogan has diminished its descriptive accuracy, since trucking and other "deregulated" industries actually operate under a wide range of regulations governing driver certification, hazardous materials handling, equipment usage, and a myriad of others. Arguably the replacement of institutional with market regulation has caused government to implement even more such regulations than it would have in the absence of unfettered market regulation, making regulation more extensive than ever (Belzer 1994b).

The removal of economic regulation created competitive pressure that squeezed carriers and labor. Operating on an extremely tight operating margin, technological innovation thus has become a two-edged sword: correct and appropriately-scaled technological investments that increase service and reduce cost can be the difference between a successful carrier and a failed one.

In this paper I argue that this policy shift to increased competition fundamentally changed the trucking industry, making it one of the most competitive industries in the U.S. I first address the nature of the institutional change in trucking and discuss the impacts on the labor market. Changes in the industrial relations environment have led to changes in the work process and in industrial relations outcomes. In response to these competitive challenges, advances in information technology have been adopted throughout the trucking industry to enhance carriers' competitiveness and meet customers' demands. This new technology increased the performance pressure on drivers and dockworkers who must meet more stringent time schedules under adverse conditions. Finally, the competitiveness induced by deregulation has meant that technological innovation has been implemented in the presence of wage declines and enhanced

work demands — and sometimes driven by changes in the labor force produced by the forces of competition. I consider new evidence that technological changes have made trucking industry workers more service-oriented, faster-paced, and more technologically sophisticated.

This paper also reports results of a case study of one sector of the general freight trucking industry, the less-than-truckload (LTL) sector. Scholars working with the University of Michigan Trucking Industry Program (UMTIP) undertook this study in order to better understand all facets of the LTL industry, including operations, work rules and safety, wages and benefits, hiring and recruiting, and other broader business functions including corporate strategy, marketing, and managerial accounting. The study, conducted from 1997 through 1999, included fourteen motor carriers on which we collected data on more than two thousand questions. The data, which are proprietary and include sensitive business information, provide the basis for benchmarking analysis of firms, which is ongoing.

II. Institutional Change

With the passage of the Motor Carrier Act of 1980 under the Carter Administration, institutional regulation formally gave way to economic regulation. Much has been written about deregulation in trucking, some objective and some quite political. Perceptions regarding the success or failure of deregulation may depend on one's position in the market, but it clearly created a very competitive environment and the public debate over

truck safety suggests perceived increasing negative externalities (for a review, see Belzer 2000: Chapter 3).

A summary of the elements of deregulation includes:

- Freedom of entry;
- Reduced and then eliminated collective rate-making;
- Reduced rate-bureau authority;
- Required tariff filing for many years after 1980 but carriers were allowed to mask filings using customer numbers;
- Eliminated antitrust immunity;
- Permitted rate discrimination which led to discounts favoring larger shippers over smaller shippers;
- Eliminated gateways and indirect routings;
- Eliminated the "Rule of Eight" for contract carriers;[1] and
- Expanded hauling rights of formerly exempt and private carriers, blurring the distinctions between them and the common and contract carriers (whose distinctions also became blurred).

A summary of the consequences includes:

- Increased safety regulation (e.g., the establishment of a commercial drivers license; increased drug and alcohol testing) to address perceived deterioration in highway safety, a negative externality;
- Industry concentration in less-than-truckload (LTL) and package carrier markets;
- Substantial consolidation in truckload (TL) creating very large (though not market-dominant) carriers;
- Industry segmentation (e.g., between LTL and TL);
- National and multi-national LTL and TL carriers
- Lower wages and most likely longer miles and more hours of work, especially in TL and unpaid non-driving work hours in TL;
- Lower profits and bankruptcies of carriers, along with widespread unemployment and employment dislocation during the first three years of deregulation;
- Increased employment over the long term as the industry's share of the national freight bill increased steadily; and
- Increased number of carriers, particularly in the TL sector.

Trucking Industry Sectoral Definitions.

The less-than-truckload (LTL) segment of the general freight trucking industry hauls shipments that are less than 10,000 pounds. The typical shipment is approximately 1,000 pounds. Their operations require extensive pickup-and-delivery networks and terminals in which to sort freight headed for multiple destinations (Belzer 2000: 202). Depending on the definition

of the industry's scope, the market is one of the most heavily unionized in the trucking industry, though unionization has declined substantially since 1995 (Belzer 2000: 109).

The truckload (TL) segment of the general freight trucking industry hauls shipments that are greater than 10,000 pounds. The typical shipment is larger than 25,000 pounds and fills one truck. Truckload carriers are almost entirely non-union. This sector requires no terminals in which to sort and segregate freight to multiple destinations. While network efficiencies are important, an individual carrier only needs a telephone and a truck to get into the business.

Package carriers such as United Parcel Service and Federal Express handle relatively small shipments, averaging perhaps 10 pounds. They operate vast pickup-and-delivery networks and feed them into "hubs" where they use elaborate conveyor systems and automated package identification systems to sort freight quickly and accurately for delivery by truck or airplane (mainly by truck).

The remainder of the trucking industry includes specialized carriers (carriers hauling special commodities, such as automobiles, bulk solids and liquids, and other specialized items), local cartage (carriers that haul only within a local metropolitan area) and drayage (carriers hauling intermodal freight, either in piggyback or container boxes.

Commonly, those truck drivers who own their trucks are called "owner-operators." The use of the term "owner-operator" is political, however, and hence controversial. Since 90% of these individuals hire themselves out to motor carriers with operating authority and operate under that authority (a reliable estimate using the UMTIP truck driver survey), one may argue persuasively that they are employees who lease equipment that they own to the carrier; arguably, the transactions are quite separate. Historically the Teamsters have represented this group and only during the past three decades have they been excluded (Leiter, 1957, reprinted 1974: 82-86).

Technically, the proper and non-politicized term for these individuals is "owner-driver," as they own the truck and drive it; most of these drivers lease their truck to a motor carrier and rent their labor to carriers in the same general fashion as do employees. The 10% of owner-drivers who have and use their own operating authority and who secure their own loads should be called "owner-operator drivers," because they own and operate their trucks independently; essentially they are small motor carriers.

Changes in Industrial Organization with Labor Market Consequences.

The nature of competition lies at the heart of the problem of industry structure. Some neoclassical economists have argued that any market that is contestable is also competitive. Under this theory, a monopolistic market may be competitive as long as there are no institutional restraints preventing entry. This theory has spawned a great deal of controversy, and today the shortcomings of the theory are recognized. However, the theory has had great sticking power and arguably underlies much of the current debate over antitrust policy (Baumol, 1982; Baumol et al., 1982; Shepherd, 1984; Baumol et al., 1986; Call and Keeler, 1985; Morrison, 1987; Leigh, 1990).

The conventional view of competition in a market place, from the economics of industrial organization, has considered market share to be a strong indicator (though not solely deterministic) of competitiveness (Shepherd, 1979). As discussed above, some sub-markets within the trucking industry have consolidated substantially since deregulation. Certain markets in LTL are very competitive while others have far fewer competitors (Rakowski 1983, 1995; Roberts 1992). Truckload is understood to be quite competitive, though some carriers have become quite large and exert some effect on the marketplace (Corsi 1993). Owner-drivers (truck drivers who drive their own trucks, some 80 percent of whom are permanently leased to

certificated motor carriers) are price-takers (i.e., have no power over the market price), and their use has increased since deregulation (Peoples and Peteraf, 1995). Data collected by UMTIP suggest that the owner-drivers may earn the least of all driver groups in trucking. For drivers, one important side effect of segmentation comes from the fact that market share is an important determinant of wage levels. Consistent with expectations, the larger the carrier (that is, the greater the carrier's market share) the higher the wages. Measurements from 1977, 1982, 1987 and 1990 show that this effect also has increased over time as carriers have grown (Belzer 1993).

Changes in productivity are unclear. Some data indicate productivity has gone up, some indicate productivity is down (Duke 1992). Measurements are poor because data are inadequate. Most likely the cost of truck transportation (and its fraction of the GDP) has gone down, but most of the cost savings probably results from lower wages, especially among truck drivers but including most industry personnel (Winston et al., 1990). Much of the hype over savings turned out to be illusory as a well-known and oft-cited industry analyst recently admitted to having made a minor miscalculation (failure to correct for inflation) that produced major measurement error (Bearth, 1999).

Deregulation of trucking caused rapid restructuring of the industry. Hundreds of motor carriers went out of business and those that survived restructured to meet new competitive demands. The regular common carrier sector completely came apart, splitting into LTL and TL carrier segments. The LTL sector — really the remaining remnant of the old Class I common carrier group — now consists of a greatly reduced number of carriers that now specialize in LTL freight to the exclusion of almost all else. The TL sector, consisting of some existing general freight and special-commodity common and contract carriers along with new entrants and newly grown Class II and Class III carriers, developed quite quickly, creaming the good TL freight

from the common carriers' business base and establishing a new standard of low-cost truck service. While many of these carriers have grown quite large, none of the TL carriers has the market share that the largest LTL carriers have (for a more detailed review, see Belzer1994a; 1995; 2000).

Trucking now encompasses more than 80 percent of the cost of transportation of freight in the U.S. (Transportation Policy Associates, Serial). Truck driving is a growing occupation with employment expected to increase 17 percent between 1998 and 2008, adding 593,000 jobs (U. S. Department of Labor, Bureau of Labor Statistics, 2000). Although carriers have greater needs for drivers, this demand has not translated into increased wages (which might have alleviated the labor shortage claimed by industry), probably due to the permeability of the labor market at the bottom (anyone can enter as a driver or even as a motor carrier with minimal qualifications). Real wages have declined 30 percent since 1980, and although other blue collar workers suffered some declines, trucking wages declined farther and faster than those of other major groups, except construction workers. Further, since most intercity drivers are paid by the mile or according to a percentage of the revenue earned by the trip, non-driving labor time is generally unpaid and drivers earn no premium wage for working more than 40 hours per week. Subcontracting has increased significantly, adding to the "sweatshop" environment. With the current work week averaging more than 65 hours, carriers have marched down the labor market queue in their hiring and now see a labor force that does not meet their needs (Belzer 1993).

This major structural change, along with countless smaller changes in the competitive environment for all carriers, did not take place in a vacuum. The 1980s was a decade of structural change throughout the American economy, with downsizing, layoffs, leveraged buyouts, and wage and benefit retrenchments throughout the manufacturing, agricultural, and

service sectors. The decade began with runaway inflation and soaring interest rates which were squelched sharply by tight monetary policy and the deepest recession since the Great Depression. The terms "rust belt," "runaway shop," and "deindustrialization" characterized a decade in which economic competitiveness developed new meaning and decades of post-WWII income convergence reversed course, widening the gap between economic winners and losers.

There may be some positive relationship between a nation's development and its reliance on trucking, which is consistent with a long stream of research indicating that transportation of goods and people is an essential element of industrial development and modernization. Several reasons have been advanced to explain the increasing demand for trucking.

- Expansion of Trade. Trucking is an essential mechanism for moving freight and an expansion of trade leads to more trucking. Whether trade is among the NAFTA countries or between the U.S. and either Europe or Asia, goods must move from point of production either to a consumption point or to a transshipment point, at which the goods move from the trucking mode to either air, rail, or water transport. For almost all goods, especially those of high-value, motor carriage will be either the first mode, the last mode, or both. The majority of the freight shipped to the Port of Los Angeles/Long Beach via steamship from Asia still will travel by truck from the port to the consignee anywhere in the western states, and for service reasons a great deal of this long-distance freight will move by truck to consignees throughout the U.S. Outsourcing of component production also has led to a greater reliance on trucking. As manufacturing firms concentrate on their core business, they often outsource many components to other manufacturers. Most of this freight, consisting of intermediate production units, will travel by truck.

- Lean Manufacturing and Lean Distribution. Another trend developed during the 1980s and was extended throughout the economy in the 1990s: lean manufacturing. Lean manufacturing reduces inventories within a manufacturing operation facility to the slimmest possible levels. Manufacturers maintain the least inventory carrying cost but must have their products delivered just in time for use. Ideally, lean manufacturers like to "live unload" incoming components and send them directly to the line "just in time" for assembly on the line.

  "Live unloading" is a lean manufacturing process, based on Just-In-Time (JIT) delivery, involving precise coordination within the supply chain. The transportation operation (usually a motor carrier) delivers a load of components that are unloaded from the truck and delivered directly to the assembly line, "just-in-time" for installation. In some live unloading JIT environments (particularly automotive seats), the supply parts are sequenced in the order they will be needed on the line. They come off the trailer in the precise order they will be used by the assembly plant. This process saves inventory cost, storage cost, and double handling.

  This concept of lean manufacturing also can be extended to all forms of distribution. Distributors ideally would like to cross-dock incoming products and obviate the necessity of warehouse storage (and multiple handling). In addition, any excess inventory costs money, and in a competitive and quickly changing world heavy inventory overhead can burden a company, eventually making it noncompetitive in the marketplace. Lean manufacturing and lean distribution all revolve around the same principles and put the same level of demands on trucking.

- New Forms of Trucking Services. Trucking has adapted to these changes, creating new forms of service to meet the changing demand. Just-in-Time (JIT) services have been created to provide logistics support to lean manufacturing. Structurally these services have taken many

forms, but consistent among them are efforts to rationalize the process and make it more efficient. One of these efforts involves the creation of "milk runs" and other forms of scheduled services. A carrier responsible for inbound logistics may organize relatively small shipments into milk runs, allowing the carrier to schedule pickups sequentially to maximize efficiency and deliver to an assembly plant on a tight schedule. New carriers have developed these services, terming the broad service concept as logistics.

- Third Party Logistics. These emerging firms take over a manufacturer's transportation department, essentially acting as if the transportation department had been outsourced (which frequently is the case). These firms, commonly known as third-party logistics providers (3PLs), organize the process using information technology they may possess to streamline information management. Third-party logistics firms may be asset based (i.e., have their own equipment or be closely connected to a firm that provides the equipment) or may be non-asset based (i.e., contract with motor carriers and other freight carriers to haul the goods). Logistics firms, however, intensify the competition among transportation service providers as they use their expertise and technology, along with their control of the market, to whipsaw carriers against one another to secure the lowest price.

The Squeeze on Truckers.

The squeeze comes especially from the third-party providers who contract with motor carriers. Those who outsource the actual transportation service often engage carriers in bidding wars and put continual pressure on their contractors to provide the

service cheaper. In this way the original equipment manufacturer, or final manufacturer, pressures the third-party logistics provider to cut its price, and the latter (in addition to any efficiencies it can develop using technology and work organization) will in turn put the pressure on the trucker. In 2000 Daimler-Chrysler, faced with mounting losses, demanded that all suppliers, including truckers, cut their prices five percent during the next year, regardless of consequences (which were to force more carriers out of the market). The 3PLs, which are contracted directly to the automobile manufacturers and who subcontract the actual transportation, simply passed on the demand to the truckers. The truckers have nobody to squeeze for that 5% except their employees and their own profits, forcing more of them to abandon that freight. The 3PLs then solicit for carrier bids and someone makes the low bid, losing money on the freight and hiring low-end drivers, only to face the same dilemma the following year. This churning produces great instability in the market for both carriers and drivers, turning to ever cheaper drivers to do the work.

In the retail world, the same process is carried out by large retailers, like Wal-Mart, that dominate their suppliers. In this case the large retailer (the competitive end purchaser) contracts with suppliers to provide goods at the cheapest possible cost, then puts further pressure on them to cut cost again. This supplier in turn contracts with shipping firms (including major steamship lines that transport containers overseas), demanding the cheapest possible price. The steamship company, using “store-door” rates, secures its profits first and then sets what ends up being an impossibly low price for the trucker. While many reputable motor carriers will not haul freight on this basis, because they cannot operate profitably and pay their drivers at that rate, at the fringe there always is some carrier or individual operator who will. This results in a kind of extreme pressure that ultimately rests on unorganized truckload drivers and owner-operators who work at well below the average rate for drivers elsewhere in the market place. This kind of economic pressure has led to owner-operator strikes in many ports across the U.S. in recent years.

Deregulation in other transport industries.

Deregulation was not confined to trucking. Other major transport modes (notably railroads and airlines) were "deregulated" in a move to increase competitive pressures on firms and on employees in the name of increased allocative efficiency. The deregulation of railroads resulted in great industry consolidation (only four Class I railroads remain), spin-offs of short lines (frequently non-union with lower wages and intensified work), abandonment of trackage and "demarketing" of customers, and reduction in competition (economic theory predicts that monopolies will reduce service and raise price in order to maintain profits). Real wages at the Class I railroads remained constant for more than a decade and only recently have inched downwards (Talley, 1998).

The deregulation of the airline industry led initially to greater competition and new service, but most new entrants failed and competition arguably declined as major trunk carriers consolidated around fortress hubs. On the labor side, the employees experienced some wage reductions, initially in the form of two-tier wages, and several air carriers experienced severe labor conflict (Johnson, 1995). One carrier, Eastern Airlines, collapsed in the midst of a strike that followed an innovative experiment in labor management cooperation — an experiment that new management abandoned. Another carrier, Continental Airlines, declared bankruptcy just to avoid collective bargaining. While temporarily successful, management's actions in this case led Congress to change the law, forbidding bankruptcies designed primarily to escape the collective bargaining relationship. Eventually the carrier re-unionized. During the past decade airlines have developed a new form of "two-tier" wage structure by creating regional subsidiaries that feed the trunk airlines, and wages at the regional operations are far below those at the majors (Walsh, 1994; Johnson, 2000).

The most radical transportation deregulation of all took place in the international maritime industry, where "flags-of-convenience" displaced national institutions almost entirely. When a ship is registered in a country with which it has no relationship other than registration, it is said to fly a "flag of convenience." The classic Liberian freighter, for example, may never travel to Liberia, be owned by Liberians, or be part of a domestic Liberian fleet; rather, the firm that owns it obtains its registration "flag" in Liberia because it is inexpensive to license and can be assured that the country in which it is registered will not interfere with its operations and industrial relations. Maritime employment dropped from approximately 54,000 to less than 13,500 between 1969 and 1987 (Donn 1989). Wages, staffing standards, and benefits have fallen further, and the unions have been left with very little bargaining power. International seafarers, those employed on flag-of-convenience ships in international trade, frequently pay wage and benefit levels at or below the subsistence level and may actually engage in traditional forms of recruiting bordering on impressment or slavery (Chapman 1992).

Just as regulations are non-existent or ineffective for regulating sweatshop and enslavement practices for nonlicensed crews, unqualified individuals prepared to pay a fee can obtain a license to pilot a ship. In a recent experiment to demonstrate this, International Transport Workers Federation (ITF) General Secretary David Cockroft, who acknowledges that he is totally unqualified, obtained a First Officer's license allowing him to steer ships ranging from bulk carriers to cargo ships and to deputize as Captain on Panama's flag-of-convenience vessels (International Transport Workers' Federation 2001). Cockroft obtained the license to show just how easy it is for unqualified people to obtain pilots' licenses. Indeed, the flag-of-convenience is also a license of convenience, and deregulation may put licensed but unqualified

individuals like Cockroft in command on the high seas, just as free international access to truckers may allow unqualified individuals on the highways.

Labor Market Deregulation: De-unionization and Its Effects.

An important backdrop for trucking deregulation has been the deregulation of industrial relations. From an institutional perspective, changes in the interpretation of labor law (the National Labor Relations Act, as amended) over the past two decades has made it quite difficult for unions (in this case, mainly the Teamsters) to maintain their bargaining positions on behalf of drivers and dock workers. Although changing interpretations of the NLRA during the past 40 years have adversely affected unions' ability generally to organize and bargain on behalf of employees, those changes accelerated in the 1980s. During the last two decades, strong opponents of unions were appointed to critical positions on the National Labor Relations Board. Decisions of the NLRB have restricted union rights greatly (Cooke and Gautschi 1982; Commission on the Future of Worker-Management Relations 1994a and 1994b; Gould 2000). As a

result, though 45 percent of all workers would prefer union representation (Freeman and Rogers 1999), union density in all industries has declined greatly. Less than 10 percent of private sector workers now belong to and are represented by unions and less than 20% of all trucking employees work under collective agreements. Public sector unionization is much higher, resulting in an overall unionization rate of 15 percent of the eligible work force.[2]

This deregulation of labor law has made it more difficult for the Teamsters to play a strong representational role in maintaining standards. For example, the Teamsters successfully organized a plurality of the terminals of Overnite, an LTL carrier owned by Union Pacific railroad which was the subject of a bargaining order by the National Labor Relations Board (NLRB) because of repeated and systematic violations of workers' rights to organize. These findings have been upheld by the U.S. Court of Appeals for the 4th Circuit but the case continues to drag on in court. A strike, which began in October of 1999, is still in effect (though ineffectual) at the time of this writing.

Organizing in LTL is easy compared to organizing in TL, and the Teamsters have lost all representation in the truckload general freight sector and their inability to force recognition or a first contract at Overnite sends a powerful message to any other truck drivers who might want to organize.[3]

Union representation in the for-hire sector, as measured by the Current Population Survey (CPS), has declined from a high of more than 60 percent in 1973 to under 20 percent today. Representation in private carriage is substantially lower. Deregulation exacerbated an already evident trend toward lower unionization and currently the union represents truck drivers in only a limited number of sectors (notably LTL, carhaul, grocery, and package delivery, among others).

During the 1980s, the Teamsters lost about 500,000 members, due mainly to trucking bankruptcies (of the 100 largest motor carriers in 1980, 70 have closed or either merged or were purchased by other carriers, and many of the remaining firms have downsized dramatically). Before deregulation began, the National Master Freight Agreement (NMFA) covered about 500 firms. The first shock of deregulation bankrupted nearly two hundred major Class I carriers and the resulting competition further fractured centralized bargaining in trucking, leaving only 6 carriers in the NMFA today. While the NMFA represented between 300,000 and 500,000 workers before deregulation, it represents less than 100,000 workers today, though many unionized carriers have "white paper" individual contracts that at least follow the NMFA pattern.

Collective bargaining clearly is associated with superior wages and conditions. Multiple regression has shown that unionization has played an increasingly strong role in wage determination in trucking. It also shows that unionization can limit abuses due to contingent

compensation. Research has shown, for example, that unionized drivers are significantly less likely to be required to give away time. That is, unionized drivers are significantly more likely to be paid for all of their non-driving labor time (Belzer 1995).

III. Data

From 1997 through 1999, the University of Michigan Trucking Industry Program conducted an in-depth case study of the LTL sector. Fourteen firms were interviewed in great depth by a team of two researchers and two graduate students over two days. At each firm, investigators conducted 16 separate interviews on areas including operations, fleet equipment and maintenance, human resources and industrial relations, business strategy, marketing, accounting, safety, and information technology. The interviews developed a database of approximately 2,400 answers providing both qualitative and quantitative data.

Carriers were chosen based on their size, scope, and region of operation. The sample was limited also by the willingness of the participants, because researchers asked for access to a broad range of sensitive and proprietary data (and disclosure is limited by a confidentiality agreement). The study included two of the four largest LTL national carriers (a third participated too late to get into the analysis), three multi-regional carriers, three Midwest regional carriers, two West Coast regional carriers, three East Coast regional carriers, and a carrier that is a cross between LTL and air freight. Size varied from very large (the largest national carrier has nearly 10,000 power units in intercity service) to very small (a regional carrier with only about 50 tractors in intercity service). The researchers believe this sample, while not random, is roughly representative of the industry.

The case study, directed by Michael Belzer, Associate Director of UMTIP, has provided data for several research projects. Industrial relations and human resource management scholars and other social scientists have data on collective bargaining, work rules, wages and benefits, and human resource activities such as recruiting and safety management. Operations researchers have information on network structure, optimization, and operations management. Engineers have information on intelligent transportation systems applications, routing and scheduling, fleet replacement, and fleet communications. Management experts have information on corporate strategy and marketing, as well as on elements of managerial accounting. The case study also has become a foundation for a self-funded on-line benchmarking project, allowing both transportation scholars and motor carriers to utilize production functions and other benchmarks to determine best practices for the industry.

IV. Results

Mechanical Technology. Mechanical technologies have evolved during the last 20 years, but change has been incremental. Legal changes, such as the Surface Transportation Assistance Act of 1982 and successive regulatory changes, have somewhat standardized truck size and weight across the U. S. While variation remains among states due to individual state regulations, the modal truck has a maximum gross weight of 80,000 pounds and almost all Interstate highways (i.e., highways part of the national Interstate System, posted with red, white, and blue shields and the designation "I-00[0]") must accept these vehicles. Trailers may now be as wide as 102 inches with a maximum trailer length of 57 feet. The 102-inch width allows 48-inch wide pallets to be placed side-by-side in 12 rows, with one foot to allow for the operation of the door. The 80,000 pound limit allows a maximum load of 45,000 to 50,000 pounds of freight.

Maximum overall height is 13'6", which typically allows eight to nine feet of freight stacked inside.[4] States also must allow the use of 28-foot doubles on most Interstates and many other U.S. trunk highways. These "pups" are used mainly by LTL carriers, and triple-pup configurations have been allowed by many jurisdictions, mainly western turnpikes and superhighways. The political fight over allowing triples on more highways has pitted trucking management (mainly from the LTL sector) against safety advocates. Finally, full-length double-trailer combinations (known as "turnpike doubles") have been a fixture on many toll roads for decades, establishing a long reputation for safety. While awkward, the doubles are quite stable when loaded, according to drivers. These issues of size and weight have been the source of extensive and volatile disputes in the policy arena.

Trucking company management tends to favor larger and longer trucks because of the effect on labor productivity. Increasing the truck's legal weight and length allows each driver to haul more freight, increasing both labor and capital productivity. It takes little more time or effort to pull two trailers instead of one (and combined trailer length is 56 feet, about the same as the longest allowable highway trailer), though someone (generally the driver or a "yard jockey") must hook and unhook an extra converter or "dollie," an activity which often involves some strenuous and dangerous work. While this may have slightly reduced the number of drivers needed to haul the same freight volume, the main value of doubles to the carrier comes from the fact that it may load a 28' trailer for a distant destination and not have to re-handle the freight again until it arrives at its final terminal. In fact, LTL carriers strive to load a "head haul" in the nose of the trailer at the time of original pickup and then top off that trailer with more freight to the same destination, further reducing handling activity.

These equipment advantages have at least been offset partially by the time demands on carriers. Motor carriers compete based on both price and time, and the rapid logistics demands required by lean manufacturers and distributors often require carriers, especially in the regional LTL sector, to operate trucks that are loaded well below capacity in order to make time commitments. The demand for drivers, however, has continued unabated, requiring carriers to make a trade-off between service demand and resource efficiency: A driver pulling a less-than-full trailer is achieving less than full labor and capital productivity.

From a safety standpoint, anti-lock brake technology is one of the most significant mechanical advances to affect the driver. After an aborted failure in the 1970s, anti-lock brakes improved and they are now required on all new tractors and trailers. While technological difficulties slowed the adoption of anti-lock brakes, especially on the trailer (the addition of an electrical support connection with the trailer to monitor brake sensors proved troublesome), they are coming into use now. Crash avoidance technology is used by some carriers, generally those with the greatest inherent safety risks (paying low wages in the most competitive TL sector, thus in greater need of technological help than other carriers). Such technologies include sophisticated radar mounted in the tractor, such as Eaton's Vorad, that detects the presence of a vehicle in front and, depending on relative speed of the truck and the vehicle in front, may slow or even stop the vehicle to avoid a crash. Carriers that hire less experienced drivers and pay them less have greater need for such technology. These carriers trade the higher cost of implementing the technology for a lower cost of labor. It is virtually unknown in the LTL sector, especially among the higher paid union carriers.

One technology being developed in Europe, with European Union (EU) funding, seeks to eliminate the need for drivers. Called "Promote-Chauffeur," virtual "tow-bar" technology

removes the need for a second driver in a two-truck convoy. "Platooning" would link multiple tow-bars to make it possible for one driver to lead a convoy of automated trucks. Like elephants in a circus parade, they would follow each other unerringly in special lanes or roadways restricted for this purpose (ITS International 1997; see also www.s-direktnet.de/homepages/benzconsult/echauf.htm). Obviously, this technology would dramatically increase driver productivity while reducing employment. It is not clear, however, if the public will accept this virtual platooning technology on anything except special roadways, and such special roadways are at least a long way off.

Internal computer controls have improved the efficiency of truck engines in recent years. Much like the computers assisting in the operation of automobiles, computers now control truck fuel usage and operational efficiency and record truck speeds, engine heat, engine oil characteristics, transmission shifts, and other data. This clearly has improved the efficiency of truck operations as fuel mileage has improved, and the technology now provides an activity record with which the carrier can monitor the driver.

Computer technology also has made it possible to introduce "black boxes" in trucks. These devices, known as Electronic On-Board Recorders (EOBRs), make it possible for the authorities to track the driver's driving activity. The carrier (or enforcement or investigatory agency) can use the EOBR to determine over time the driver's speed, shift patterns, braking, and other activity. Mechanics can determine engine temperature, condition of the oil, overspeeding of the engine, and other malfunctions using the EOBR. The EOBR also can be read *post-hoc* or in real time; that is, combining the EOBR with satellite or other telecommunications technology can allow the carrier to monitor the driver at will. EOBRs became quite controversial when the U.S. Department of Transportation Federal Motor Carrier Safety Administration (FMCSA)

announced a Notice of Proposed Rulemaking for truck driver hours-of-service rules which included a provision requiring such devices on all interstate trucks (U.S. Department of Transportation Federal Motor Carrier Safety Administration Notice of Proposed Rulemaking, 2000). While the strength of the technology comes from the ability to monitor truck activity and help to determine the cause of a crash, its weakness is the inability to record driver activity when the truck is not operating; it cannot help investigators or enforcement personnel determine whether a driver is waiting, sleeping, or loading, or unloading the truck.

Loading and unloading equipment remain unchanged in most types of trucking operations. In the LTL sector, which often hauls awkward freight shipments, old-fashioned equipment is still used: Johnson bars, two- and four-wheeled carts and hand trucks, carpet booms, and pallet jacks remain standard tools. Drag lines, a 1960s innovation in mechanized material handling, have disappeared from most trucking companies and now are used only at the largest terminals with the greatest standardized volume.[5] They have been replaced by motorized fork lifts, a now-ubiquitous and indispensable freight-handling machine. Most LTL carriers try to palletize as much freight as possible to simplify handling although carriers trade-off quick handling with lower cubic volume and weight utilization of trailers. For long-haul carriers this trade-off is significant, as carriers must use equipment and labor efficiently to haul long-distance freight at a competitive price. Some carriers use platforms that bisect the trailer horizontally, creating a double stack pallet environment. These carriers may market their double stack technology by providing price and other encouragements to shippers to configure their pallets so that they can fit in either the top or bottom space created by these platforms. This technology makes it easy for a carrier to load and unload a trailer quickly, using both labor and time more efficiently, while achieving an efficient use of space and ultimately achieving higher load

factors. In sum, while fork lifts have added a new hazard to the dock, unquestionably they are labor and cost saving devices.

The most significant materials-handling innovations have been developed by carriers with the highest cost per shipment and the greatest labor intensity: the package delivery sector. Carriers such as United Parcel Service and Federal Express specialize in small shipments that often require express volume handling. Both UPS and FedEx utilize conveyor belts to move small packages to the appropriate location, sorting the freight manually and mechanically, depending on the freight and the operation. UPS workers load their trailers loose, however, to gain the greatest load density, while FedEx workers load containers shaped like the belly of an airplane, filling them with loose freight destined for the same location before loading the containers into truck trailers or airplanes.

Both UPS and FedEx have adopted state-of-the-art information technologies and paired them with their conveyor mechanisms to automate these processes and reduce the need for labor while increasing velocity of freight movement. UPS, for example, uses a multidimensional "dense code" which contains customer and destination information that is read by optical scanners in several locations in the conveyor system. This code allows UPS to gain both speed and accuracy while automating the process of directing the freight to the appropriate location.

Information Technology. Trucking industry personnel describe their industry as a very simple one: The job is to pick up the freight at a shipper and deliver it to a consignee, on time and undamaged. In the truckload industry this description suffices, as ordinarily there is no further step in this process. In the less-than-truckload industry, a local "pickup-and-delivery" ("P&D") driver picks up the freight from a shipper (typically during the afternoon) and delivers it to a terminal by late afternoon or early evening. At the terminal dock workers unload the

trailer, moving each shipment onto an outbound trailer along with other shipments headed to the same destination. During the night, a road driver pulls that trailer to a terminal in another city and dock workers again unload that trailer and load it on another trailer for local delivery. The P&D driver delivers it to the consignee (typically in the morning) and goes on to pick up more freight to bring back with him to his city terminal at the end of the day. The complications in both the TL and LTL sector of the industry arise from the complex coordination of multiple trucks and drivers within a network.

Addressing this complication becomes the critical activity of the motor carrier, and the most important technological innovation for managing this activity has been the revolution in information technology. Information management has become a key function of the trucking firm. Trucking companies must keep track of their tractors and trailers, as well as containers, and both owned and leased equipment (trailers, tractors, dollies, and other equipment) that may be distributed all over the country. Furthermore, they must keep track of individual shipments as customers have come to demand continuous "visibility" of their freight. Shippers and consignees expect to be able to ask for the location of their freight (either directly or via some virtual technology, such as the Internet) and get a real-time answer. Again, the introduction of this capability has been

costly for the industry, but carriers find it to be a competitive necessity and are rapidly implementing such technology.

Internet and other electronic information exchange tools (such as Electronic Data Interchange, or EDI) provide the software on which this visibility is based. EDI, once the preferred electronic information exchange system, has not become universal, however. The protocols are used by large shippers in certain industries, notably manufacturing. In our sample we found that the average carrier sends out fewer than 18 percent of invoices via EDI, and fewer than 5 percent of bills of lading are received via EDI. EDI rarely speeds or automatically implements payment, a function which would endear it to motor carriers. National and large regional LTL carriers began using EDI in the early 1980s and others began using it in the early 1990s, but usage has not increased where it has been implemented. All EDI installations were implemented due to customer demand and often the customer was not ready for it when the carrier indicated that its implementation was complete. For carriers, therefore, EDI has not lived up to promised efficiencies and cost savings and carriers today look toward Internet-based technologies.

The growing information technology for trucking, as elsewhere in our economy, uses the Internet. Shippers and consignees now can log on to a web site and locate specific shipments. Claims for this technology seem to be ahead of their implementation as many carriers' capability is substantially less than their claims, but customers of larger carriers — TL and LTL as well as package – are on the verge of new information frontiers. Whether using html or xml, the language of the Internet and the ubiquity of common interfaces makes it the likely choice for the future.

Freight information tracking technology has an ancillary benefit to carriers: It can be used to track driver activities as well, changing a formerly unmonitored job (suited to piece work and efficiency wages) into a monitored one. Carriers now know the location of their truck to within a few hundred feet. Satellites and ground-based communications mechanisms, using new and improved cell technology, provide the communication mechanism. Carriers can send communications to drivers and drivers can send messages to carriers using satellite hardware. Costs have declined substantially as technology has advanced, both for the physical unit and for the transmission transaction. During the 1980s and into the 1990s, only the most sophisticated carriers with capital to spare could equip their fleets of trucks with this technology and take advantage of it. Costs have declined, however, and now even smaller carriers can use it. Some large carriers even equip their owner-drivers with satellites so that they can manage their owner-drivers in the same tight way that they manage their company-owned fleets.

These technologies are used differently depending on the operational needs of the carrier. Truckload firms tend to use satellites to track their equipment over long distances, allowing them to establish reliable schedules and make reliable predictions based on them. By tracking the equipment they can easily track the shipment, since conventionally they will be the same. Less-than-truckload carriers have a much more complicated task, as they need to track much smaller shipments. Some carriers do so with bar codes and other technological applications and others do so with old-fashioned paper manifests. Regardless, their task is to match the shipment with the trailer and use that information to track each shipment so that customers will be able to identify their shipments' locations. When carriers combine this technology with bar-coding of individual shipments, precise tracking becomes possible.

For the most part, less-than-truckload carriers tend not to use mobile communications with their linehaul units, because they do not believe the benefits exceed the costs: they know where their trailers are. They do not, however, always know the location of the shipment. Only a few very sophisticated carriers use automated control systems (generally linked to bar- or dense-codes) to monitor each shipment, linking the trailer on which it is loaded with the trailer movement itself to maintain a running record of freight movement. These IT investments are costly and unpredictable and carriers are cautious investing in them without some predictability of outcome; carriers whose IT investments fail frequently fail themselves. Some nonunion carriers have developed the sophisticated tracking technology to compensate for the lower skills of a less expensive work force but many union carriers have also invested in this technology, making the de-skilling versus up-skilling argument less than compelling. The evidence suggests that carriers with successful implementations have benefited from deeper IT capabilities in additional ways, gaining much greater control over shipment information management and hence over resource management.

Most LTL carriers usually have less complete and up-to-the-minute information on the location and performance of their drivers and their loads than does the advanced TL carrier. As a rule, the LTL trucker uses tight scheduling of sequential movements to track drivers and freight movements while the advanced TL carriers that use satellites can locate their drivers and monitor their activities on demand. Less-than-truckload carriers are more likely to use static, after-the-fact EOBRs (such as engine computer recorders) to identify problem drivers, for example, while TL carriers need the instant access to driver performance and activity data that satellite tracking provides. Resource constraints, however, apparently limit this practice to unusual or problem cases also, and such surveillance is not used routinely; the paperwork mountain is daunting.

One key question is: who has this technology benefited? If the technology increases the driver's efficiency, does the driver reap the benefits or do they get competed away? If the drivers do not benefit, do the carriers reap the benefit or, ultimately, does the benefit go to the shippers and consignees? Evidence from the UMTIP drivers survey suggests that the drivers do not benefit. In research based on these data, Belman and Monaco find that though drivers who use satellites earn 16.1 percent more annually, they also drive 17.7 percent more miles and work 16 percent more hours. The use of satellites is associated with 7.6 extra hours of work per week and one additional violation of the ten-driving-hour rule every 30 days. This research suggests that drivers operating under satellite control may earn a lower rate of pay while driving substantially more hours and working longer hours (Belman and Monaco, 2001). The relationship may be spurious, however, because carriers that use these technologies probably differ systematically from carriers that do not on many unmeasured characteristics. The jury is still out on technology's impact on industrial relation outcomes.

Routing and scheduling software has made motor carrier operations more efficient in all sectors and give the motor carrier more control over driver movements. While implementation of scheduling algorithms may be uneven, clearly there has been a growing trend in that direction. Initially such investments were costly and limited to the biggest carriers, but continuing innovation in this field has made the technology available to smaller firms. For LTL carriers, primary emphasis is on static optimization software designed to determine whether networks are optimally efficient, because most LTL carriers' runs are stable and change only over time. New decision-support tools, however, are designed to assist dispatchers in the most efficient and effective assignment of drivers to those nightly runs which are not routine. For TL carriers, primary emphasis is on decision-support systems that are designed to assign drivers optimally to

loads depending on their location, their available hours, their equipment, and the number of empty miles incurred. For both of these applications, efficient algorithms are needed to handle these solutions in an operationally efficient matter. Regardless of the speed and power of the computer, these problems are inherently so complex that only advanced forms of mathematical assignment may achieve a result quickly enough to be useful.

Technology and Driver Safety. Does technology help or hinder driver safety? Some kinds of technology, such as crash avoidance technology, likely does help. The major source of the truck safety problem, however, lies in the quality of the work force and the incentives used to motivate and reward them, combined with the number of hours worked and miles driven. Research suggests that after deregulation, as real trucking wages declined and work intensified (creating worsening working conditions), experienced drivers exited the industry and were replaced by drivers who were both less experienced and who had other less-desirable. These drivers appear to have weaker safety records and are more likely to make the sorts of mistakes that lead to crashes, or drive too far or work too long, leading to more crashes.

V. Conclusion

The trucking industry has experienced a drastic change in competitive forces in the past 20 years. These changes have led to longer hours and lower wages and arguably to greater risk to drivers' health and safety. They have also led carriers to implement new technologies, especially information technology, to compete successfully. While basic freight handling has undergone marginal changes (manual fork lifts giving way to powered fork lifts; drag lines and hand carts giving way to conveyors), and various truck technology improvements have led to

greater safety (anti-lock brakes and collision avoidance technology), the basic work process has not changed greatly.

The greatest changes have come from the introduction of information technology. Carriers use sophisticated routing and scheduling algorithms to increase the efficiency of their dispatch systems and hence the efficiency with which they use labor. Modern computing systems, with processor speed and storage capabilities hundreds of times greater than those of the biggest and fastest computers a human generation ago, allow carriers to process information efficiently and maximize their use of resources. Satellites and other modern telecommunications devices have made it possible to communicate with the truck and driver, monitoring both the truck's mechanical activity and location as well as driver practices. With the advent of the Internet, carriers can attempt to track shipments and vehicles to provide nearly real time information management, overcoming one of the greatest transportation problems.

The next era may see the longer and heavier trucks, but public resistance is a major issue. Carriers have squeezed the maximum out of the driver, though incremental improvements may provide competitive advantage. Attempts to increase truck size and weight have met with strong political resistance in recent years, and though national crises have been invoked to spur past increases, such options may be limited. The current fight by large LTL carriers to extend the use of triple trailers to more highways (an obvious way to increase driver productivity by as much as 50 percent) has been unsuccessful because the public perceives them as unsafe, a perception also fueled in part by railroad industry lobbyists. Thus further increases in labor productivity based on larger trucks are unlikely to be very successful.

The most important battle currently is over truck driver hours of work. Drivers now are limited to 10 hours driving per day (actually 10 hours, followed by an eight-hour break, and

another six hours may be driven maximum) and 15 hours total labor (driving and non-driving, though again a driver may backward-rotate his schedule by one hour after a 15-hour work day and actually work 16 hours legally), and 60 hours total per week (drivers may work 60 hours in a seven-day week or 70 hours in an eight-day week). An attempt to increase the number of daily driving hours while reducing overall work hours to 12 (leaving the 60-hour work week alone) met with extreme resistance from trucking industry groups (most carriers, owner-operators, and others currently working over the current limit, which is the majority) and opposition from safety advocates as well, and was killed in Congress by the end of 2000. This does suggest that while technological change is important, the change frontier in trucking lies in industrial relations solutions.

REFERENCES

Baumol, William J. "Contestable Markets: An Uprising in the Theory of Industry Structure." *American Economic Review* 72 (1982):1-15.

Baumol, William J., John C. Panzar, and Robert D. Willig. *Contestable Markets and the Theory of Industry Structure*. San Diego: Harcourt Brace Jovanovich, 1982.

_____. *On the Theory of Contestable Markets*. Cambridge: MIT Press, 1986.

Bearth, Daniel P. "Cass Logistics Formula Flaw Inflates Deregulation Savings." Pg. 4 in *Transport Topics*. Alexandria, VA, 1999.

Belman, Dale L., and Kristen A. Monaco. "The Effects of Deregulation, De-Unionization, Technology, and Human Capital on the Work and Work Lives of Truck Drivers." *Industrial and Labor Relations Review* 54 (2001): 502-524.

_____. *Collective Bargaining in the Trucking Industry: The Effects of Institutional and Economic Restructuring*. Ithaca, NY: Cornell University, 1993.

_____. "The Motor Carrier Industry: Truckers and Teamsters Under Siege." Pp. 259-302 in *Contemporary Collective Bargaining in the Private Sector*, edited by Paula B. Voos. Madison, Wisconsin: Industrial Relations Research Association, 1994a.

_____. *Paying the Toll: Economic Deregulation of the Trucking Industry*. Washington, D.C.: Economic Policy Institute, 1994b.

_____. "Collective Bargaining After Deregulation: Do the Teamsters Still Count?" *Industrial and Labor Relations Review* 48 (1995): 636-655.

_____. *Sweatshops on Wheels: Winners and Losers in Trucking Deregulation*. New York: Oxford University Press, 2000.

_____. "Worker Representation in the Truckload Sector: What Do Truckers Want?" *Proceedings of the 53rd Annual Meeting of the Industrial Relations Research Association*, January 4, 2001, New Orleans, Louisiana. Urbana-Champaign: Industrial Relations Research Association, forthcoming.

Call, Gregory D., and Theodore E. Keeler. *Airline Deregulation, Fares, and Market Behavior: Some Empirical Evidence*. Cambridge: Cambridge University Press, 1985.

Chapman, Paul K. *Trouble on Board: The Plight of International Seafarers*. Ithaca, N.Y.: ILR Press, 1992.

Commission on the Future of Worker-Management Relations. "Fact Finding Report." Washington, D.C.: U.S. Dept. of Labor; U.S. Dept. of Commerce, 1994a.

Commission on the Future of Worker-Management Relations. Report and Recommendations. Washington, D.C., U.S. Dept. of Labor; U.S. Dept. of Commerce, 1994b.

Cooke, William N., and Frederick H. Gautschi III. "Political Bias in NLRB Unfair Labor Practice Decisions." *Industrial and Labor Relations Review* 35 (1982):539-549.

Corsi, Thomas M. "Motor Carrier Industry Structure and Operations." In *International Symposium on Motor Carrier Transportation*. Washington, DC: National Academy Press, 1993.

Donn, Clifford B. "Concession Bargaining in the Ocean-Going Maritime Industry." *Industrial and Labor Relations Review* 42 (1989): 189-200.

Duke, John. "Productivity Measures for Transportation Industries." in *Highway Related Transportation Industries Productivity Measures Symposium*. Washington, DC, 1992.

Freeman, Richard B. *When Earnings Diverge: Causes, Consequences, and Cures for the New Inequality in the U.S. Washington*. National Policy Association, 1997.

Freeman, Richard B. and Joel Rogers. *What Workers Want*." Ithaca, NY: Cornell University Press, 1999.

Gould, William B. IV. *Labored Relations*. Boston: MIT Press, 2000.

International Transport Workers' Federation. "Danger: Licences for Sale." *Journal of the International Transport Workers' Federation*. 2(5) (June 2001).

ITS International. "Chauffeur aims to relieve truck drivers." *ITS International* 8 (January-February 1997): 67-68.

Johnson, Nancy Brown. "Pay Levels in the Airlines Since Deregulation." In *Airline Labor Relations in the Global Era: The New Frontier*, edited by Peter Cappelli. Ithaca, NY: ILR Press/Cornell University Press, 1995.

_____. "Airline Industrial Relations Following Deregulation." In *The Proceedings of the 52nd Annual Meeting of the Industrial Relations Research Association*. Champaign, IL: Industrial Relations Research Association, 2000.

Leigh, Laurence E. “Contestability in Deregulated Airline Markets: Some Empirical Tests.” *Transportation Journal* 30 (1990): 49-57.

Leiter, Robert D. *The Teamsters Union: A Study of Its Economic Impact*. New York: Octagon Books, a division of Farrar, Straus and Giroux, 1957 (reprinted 1974).

Morrison, Steven, and Clifford Winston. “Empirical Implications and Tests of the Contestability Hypothesis.” *Journal of Law and Economics* 30 (1987): 53-66.

Peoples, James H., and Margaret Peteraf. “Deregulation and the Competitive Fringe: Owner-Operators in the Trucking Industry.” *Journal of Regulatory Economics* 7 (1995): 27-42.

Rakowski, James P. “The Nature of Competition in Common Carrier Trucking: Economic Theory Meets the Reality of the Marketplace.” Pp. 179-189 in *Boundaries Between Competition and Economic Regulation*, edited by J. Rhoads Foster, George R. Hall, Stevan R. Holmberg, Charles F. Phillips Jr., and Richard L. Wallace. Washington, D.C.: Institute for Study of Regulation, 1983.

_____. “Victors and Victims in Less-than-Truckload Transport Since Deregulation.” *Journal of Transportation Law, Logistics and Policy* 62 (1995): 426-441.

Roberts, Paul O. “Comments on ‘The U.S. Motor Carrier Industry Long After Deregulation’.” in *Proceedings of the 35th Annual Meeting of the Transportation Research Forum*, 1992.

Shepherd, William G. *The Economics of Industrial Organization*. Englewood Cliffs: Prentice-Hall, 1979.

_____. "Contestability" vs. Competition." *American Economic Review* 74 (1984): 572-587.

Talley, Wayne K., and Ann Schwarz-Miller. "Railroad Deregulation and Union Labor Earnings." in *Regulatory Reform and Labor Markets*, edited by James H. Peoples: Kluwer Academic Publishers, 1998.

Transportation Policy Associates. Serial. *Transportation in America: A Statistical Analysis of Transportation in the United States*. Washington, D.C.: Transportation Policy Associates.

U. S. Department of Labor, Bureau of Labor Statistics. *Occupational Outlook Handbook 2000-01*. Bulletin 2520. Washington, DC: U. S. Government Printing Office, 2000.

U. S. Department of Transportation, Federal Motor Carrier Safety Administration. "Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Proposed Rule; Notice of proposed rulemaking (NPRM);" 49 CFR parts 350, 390, 394, 395, and 398; published in the *Federal Register* Vol. 65 No. 85: 25539-25611), May 2, 2000.

Walsh, David J. On Different Planes: An Organizational Analysis of Cooperation and Conflict among Airline Unions. Ithaca, NY: ILR Press, 1994.

Winston, Clifford , Thomas M. Corsi, Curtis M. Grimm, and Carol A. Evans. *The Economic Effects of Surface Freight Deregulation*. Washington, D. C.: The Brookings Institution, 1990.

[1] The "Rule of Eight" was an Interstate Commerce Commission rule allowing a contract carrier to service a maximum of eight shippers. The ICC considered that any carrier serving more than eight shippers was offering its

services to the public and thus should be classified as (and certificated as) a common carrier. Obviously the rule seems rather arbitrary to us today but this was the logic the ICC used.

[2] The concept “eligible workforce” is important. Legislation and evolving industrial practice has reduced the number of workers eligible for collective bargaining. The Taft Hartley Act removed supervisors from eligibility in the private sector and reduced professionals’ ability to seek and secure representation. Industrial restructuring has altered the work force over the past half century as well, as more workers are classified either as contingent workers (part time or temporary); indeed, an entire new industry specializes in the employment of temporary workers. Further, many jobs have been systematically restructured and outsourced, removing those employees from eligibility. In trucking, perhaps 300,000 drivers now are classified as “owner-operators” and hence independent businessmen, even though about 80% of those are permanently leased to motor carriers and look and act the same as employee drivers (except that they are responsible for purchasing, maintaining, and fueling their own trucks).

[3] A survey conducted in November and December of 2000 found that by a 2:1 margin, both company drivers and owner-drivers at a single TL carrier would vote for a union, given the chance. Under the current labor law regime, they will never get that chance (Belzer, 2001).

[4] Some carriers, such as package carrier UPS, use deep-belly trailers and smaller tires and wheels to haul as much volume as possible, since the weight of their freight rarely causes them to approach maximum weight limits. This presents problems for loaders since they must load freight quite high off the floor of the trailer, and may contribute to their relatively high loader injury rate.

[5] One well-known case is the capital-intensive Roadway Express terminal in High Point, NC. This major facility uses both draglines and oversized conveyors to process specialty freight picked up in that region.