The impact of lean manufacturing on sourcing relationships

Thomas H. Klier

During the last decade, U.S. manufacturing has experienced various changes in its cyclical and structural environment. Among them are the severe back-to-back recessions of the early 1980s and the widespread restructuring efforts undertaken in its wake, as well as increased foreign competition, great exchange rate volatility, and most recently, the build-down in the defense sector. In addition, the very core of manufacturing has been changed by the introduction of a new paradigm, the so-called lean manufacturing system. It deserves special attention because of its potential long-term effects.

Since the early 1980s, manufacturers have moved away from the traditional Fordist system of mass production toward a system of lean production.[1] Fordism separated intellectual and manual work and broke down the latter into easily learned, repetitive steps. Based on a continuously moving assembly line, Fordist manufacturing could mass-produce a limited number of models at very low cost and therefore came to dominate most of the world's manufacturing from the mid-1950s through about 1980. Lean manufacturing, by contrast, emphasizes quality and a speedy response to market conditions, using technologically advanced equipment and a flexible organization of the production process. By all accounts, lean manufacturing is a more efficient system of production. Aoki (1988) suggests this is because its methods of organizing and coordinating production allow a speedier and more timely horizontal coordination between different manufacturing operations and a subsequent reduction in costly inventory.

Lean manufacturing was pioneered and first applied successfully by Toyota Motor Company in the 1950s; since then it has become the practice of many Japanese manufacturing companies.[2] Recently American manufacturers have adopted it in order to compete effectively both at home and abroad. Adopting lean manufacturing also affects the way a company is managed and how it structures its relations with customers, employees, and suppliers; the ramifications of this change extend far beyond the shop floor of the assembly plant.[3]

U.S. automakers introduced lean manufacturing rather quickly. In turn, they greatly influenced the way many other businesses organized their factories, especially auto suppliers. The Midwest felt the greatest impact from these developments since it is the center of automobile assembly in the U.S. (see figure 1).[4] Complementing recent work by Ballew and Schnorbus, this article examines how the introduction of lean manufacturing affected the structure of the auto supplier industry and the relationships between assembler and supplier companies.[5]

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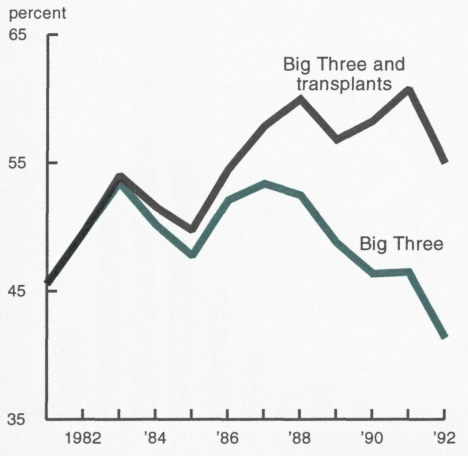
FIGURE 1

Midwest's share of U.S. car production



Source: *Ward's Automotive Yearbook* (1982-93).

The changing structure of the automobile supplier industry

The U.S. automobile supplier industry is large and diverse, encompassing firms that produce thousands of different parts, from a simple gas cap to a complex engine. Table 1 outlines the recent trends in the motor vehicle parts and accessory industry as defined by standard industrial classification (SIC) 3714, "motor vehicle parts and accessories." The establishments in SIC 3714 account for about two-thirds of all shipments of automotive parts and stampings.[6] As it is almost impossible to describe the industry by means of published census data, the following analysis draws on other sources of information.[7]

The structure and development of the automobile supplier industry must be analyzed in the context of developments in the automobile industry, since the demand for suppliers' products is derived from the demand for automobiles. Cyclical and structural conditions of the auto industry also tend to shape the supplier industry.[8] The major recent structural change to affect the auto industry has been the implementation of lean manufacturing techniques. Lean manufacturing is characterized by an emphasis on product quality; quality controls are incorporated into the production process, for example through the use of "lean" inventory stocks for intermediate and finished goods, and through including multiple responsibilities in individual job descriptions and encouraging worker participation in production management. Lean manufacturing takes an integrated approach to the various aspects of manufacturing. The idea of a concurrent design process forces everyone who at some point has a stake in the product to work closely with designers instead of coordinating the various functions sequentially from design to assembly. For example, production engineers can voice their concerns during the design process and that way improve ease of manufac-

TABLE 1

Employment, shipments, and value added for the auto supplier industry*

Year	Total employment	Shipments	Value added	Value added per employee
	(thousands)	*(million dollars)*	*(million dollars)*	*(thousand dollars)*
1979	459	39,807	18,034	39.3
1980	369	32,881	14,719	39.9
1981	359	37,081	17,254	48.0
1982	321	36,293	16,765	52.2
1983	338	44,415	21,593	63.9
1984	382	52,583	23,888	62.6
1985	385	57,931	26,094	67.7
1986	377	57,394	24,374	64.7
1987	389	62,007	26,426	67.9
1988	401	69,049	28,731	71.7
1989	393	65,683	26,458	67.3
1990	389	64,875	26,871	69.1
1991	370	63,604	25,213	68.2

*Defined as SIC 3714.

Sources: U.S. Department of Commerce, (1979-1991, 1987).

turing of the product early on in its life cycle. Finally, lean manufacturing relies on subcontractors to produce a greater proportion of the value added and emphasizes speed in order processing, production, and delivery. The successful start-up of Japanese transplant assembly facilities in North America and Europe demonstrated the transferability of lean manufacturing to other socioeconomic environments. Resulting competitive pressures forced its adaptation by the Big Three. In turn, the automobile supplier industry in the U.S. has been undergoing a transition of its own.

Coinciding with the arrival of Japanese transplant motor vehicle assembly plants, about 260 transplant supplier companies have set up shop in the United States since 1981 (see figure 2).[9] The vast majority have located in the Midwest, close to the Japanese transplant assembly plants (see figure 3). While at the outset transplant suppliers mainly supplied the transplant assembly plants, they have since been competing for business from the Big Three. The presence of supplier companies with experience in the application of lean manufacturing increased the pressure for domestic suppliers to adopt the new techniques.

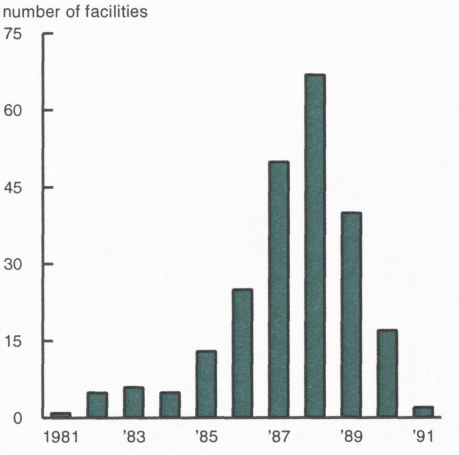
Given lean manufacturing's emphasis on low inventories and frequent deliveries, sourcing relationships based on lean manufacturing can function best when supplier and receiver are located fairly close to each other.[10] An analysis of the geographical pattern of the locations of Japanese auto assemblers and suppliers in the U.S. bears this out.[11] Japanese suppliers operating in the U.S. are typically located within about a 200-mile radius, or five hours' driving time, of their main customer.

As table 2 indicates, the domestic auto industry is still dominated by captive parts companies that are part of the corporate structure of the assembler (see figure 4).[12] Domestic supplier companies also show less evidence of a changed location pattern since the arrival of lean manufacturing. That is not surprising, since it would require a change in already existing locations. Yet empirical studies have found a break in the location of auto supplier companies away from the pattern which prevailed until the 1970s.[13] The change is ascribed to several factors.

First, lean manufacturing has brought an increase in the purchase of parts from independent suppliers rather than from captive parts

FIGURE 2

Transplant auto supplier start-ups



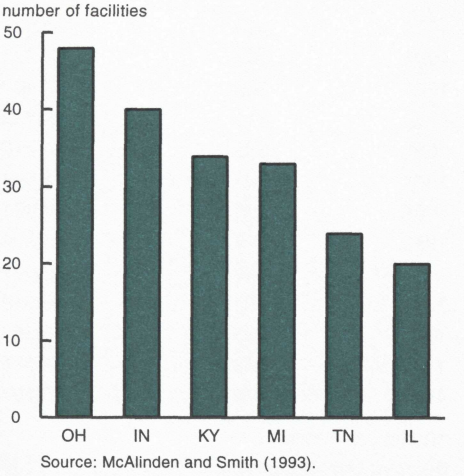
Source: McAlinden and Smith (1993).

companies. Whereas captive suppliers tend to be heavily concentrated in urban areas of Michigan, Ohio, and Indiana, newly established plants of independent suppliers are usually located in smaller communities in nonmetropolitan or outlying metropolitan counties.[14]

A second reason for the changing location pattern of domestic suppliers is that the geographic structure of auto assemblers itself underwent a restructuring, starting in the late 1970s. According to James Rubenstein, the branch assembly plant system, which was set up to minimize transportation costs by producing identical vehicles at multiple locations, was

FIGURE 3

Transplant suppliers, 1991, top six states



Source: McAlinden and Smith (1993).

TABLE 2

The ten largest first-tier suppliers in North America
(1992)

Rank	Company	Total North American automotive sales, 1992	Products
		(million dollars)	
1	GM Automotive Components Group	19,500	Systems and components: power-train, lighting, chassis, steering, braking, HVAC, batteries, engine management
2	Ford Automotive Components Group	7,200	Automotive glass, electronic controls and systems, climate controls and systems, engine accessories, trim and plastics
3	DuPont Automotive	2,500	Fibers, finishes, plastics, elastomers, composites, lubricants
4	Magna International Inc.	2,260	Systems: seating and bumper, door and panel, engine and transmission, metal body
5	Nippondenso America Inc.	1,600	HVAC, electrical and electronic products, fuel management systems, radiators, instrumentation, filters
6	United Technologies Automotive	1,600	Electrical, interior and exterior trim systems, steering, wiring products
7	Robert Bosch Corp.	1,400	Communications technology, fuel management systems, anti-lock braking systems, electronics, starters, alternators
8	The Budd Co.	1,250	Steel stampings and frames, truck wheels, hubs and drums, composite body-engine parts
9	Kelsey-Hayes Group	1,190	Anti-lock brake systems, brake components, wheels, electronic components
10	Lear Seating Corp.	1,100	Seating systems, door panels

Sources: Fleming (1993a), Payne and Payne (1990).

swept away with the fragmentation of the U.S. auto market.[15] Multiple regional assembly plants were gradually replaced by plants that produced one particular platform for the entire market.

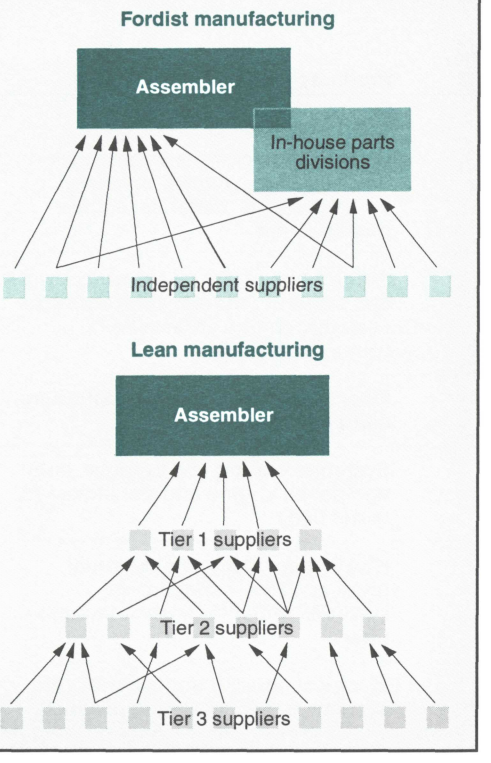
Finally, suppliers that deal directly with assemblers (so-called first-tier suppliers), providing especially large, complex, and high-value components and services, have been locating near their customers. In contrast, lower-tier suppliers, who tend to produce low value-added parts, relocated to low-wage areas in order to reduce production costs.[16]

Assembler-supplier relationships within lean manufacturing

With the arrival of lean manufacturing, the relationship between assembler and supplier companies has changed considerably. Under the Fordist system, U.S. auto manufacturers procured most parts and components from their own parts divisions (see figure 4). These sourcing relationships were supplemented by purchases from independent suppliers in arms-length transactions. Typically, a car assembler dealt with 1,000 to 2,500 suppliers directly.[17] Contracts with independent suppliers usually

FIGURE 4

Assembler-supplier relationships



ran no longer than a year. The assembler relied on hierarchical coordination of information and control over technology in order to solve the complex task of manufacturing cars.

The tier system

Today, rather than centrally coordinating almost its entire supply structure, an assembler deals directly with only a small number of supplier companies, referred to as first-tier suppliers. Most first-tier suppliers deliver fairly aggregate parts or entire systems rather than individual bits and pieces. Such an arrangement has greater informational efficiency and therefore appears to have a competitive advantage over the Fordist system.[18] Indicative are the results of a study conducted in Japan in 1977 to establish the supply tiers for one particular auto assembler. While the company's supplier pyramid contained over 35,000 suppliers, the company dealt directly with only 122 of them, its first-tier suppliers.[19] The remainder fell into the second and third tiers.

U.S. assembler-supplier relationships have also become organized in tiers.[20] In 1980, for example, Ford Motor Company dealt directly with about 2,400 North American suppliers. It has since reduced that to about 1,400 first-tier suppliers and is committed to a target of 1,150 by 1995.[21] Similar changes are occurring at the individual platform level. For Ford's recently introduced world car, called Mondeo in Europe and Contour/Mystique in the U.S., the company is working with only 227 first-tier suppliers in the U.S. That compares to 700 suppliers for the Tempo/Topaz platform, which the Contour/Mystique will replace.[22] Chrysler produces its Neon with 289 first-tier suppliers, down from 425 for the Sundance/Shadow which it replaces.[23] Changes such as these have increased the potential roles of full-service supplier companies such as Magna International, which produces entire systems for seating, bumpers, doors and panels, engines and transmissions, and metal bodies.[24] The development of the tier system has also forced changes in the relationships between suppliers. For example, as recently as 1985, Manchester Stamping, located in Manchester, Michigan, obtained its steel supply from more than 30 different companies. It has since reduced that number to five. With bigger orders it can now demand faster service.[25]

Mutual commitment

Compared to the Fordist system, lean manufacturing requires a high degree of communication and interaction between manufacturers and fist-tier suppliers, resulting in more closely-knit relationships to which both sides make various commitments. Rather than carrying large amounts of inventory for the downstream customer, supplier companies change their organization of production so as to produce "just in time." In addition, they take on responsibility for quality control and, often, research and development, activities that were traditionally the task of the assembler. Accordingly, suppliers must invest in quality control training and equipment and maintain their own product design staff. The assembler, in turn, uses single suppliers rather than multiple suppliers for each part of the platform. A recent study of the Big Three showed that for a list of 30 automotive parts, in 85 of the 89 observations the part was single-sourced.[26] In addition, the assembler makes a commitment to longer-term relations through both longer-term contracts and the extension of informal contract-renewal promises, contingent on continuous quality improvement by the supplier.

The degree of mutual commitment between assembler and supplier cannot be observed directly, but it becomes apparent in various specific aspects of sourcing relationships. A recent study measured this commitment as the number of years during which assembler and supplier work together before actually starting production.[27] During this time, supplier and assembler must reach agreement about the part's technical features, quality standards, price, and delivery schedules—an undertaking requiring significant cooperation. The more time spent on pre-production communication between assembler and supplier, the stronger the mutual commitment to the relationship. For example, Chrysler's new JA platform is scheduled to go into production later this year, yet by 1992 every major system in it had already been sourced.[28] Some supply relationships in the automobile industry are now so established that suppliers play a role in designing the automobile.

The following shows the importance of mutuality in the commitment to sourcing relationships. In the mid-1980s, Lucas PLC, a British supplier of mechanical and electrical components to the automotive and aerospace industries, began adopting lean manufacturing principles. As a result, the company reduced lead times and in-progress inventories significantly while vastly improving the percentage of orders delivered on time. However, one of Lucas's electrical component factories soon ran into problems because some of its large customers had not converted to lean manufacturing and continued to place their orders in an unpredictable manner.[29]

Knowledge transfer

Domestic suppliers are now more likely to provide detailed information to their customers than just a few years ago.[30] This reflects the need for increased communication in a lean manufacturing environment. Most notable has been the dramatic increase in information exchanged on statistical process control (see table 3). Statistical process control is a technique for generating continuous reductions in defect rates. It involves taking samples of output, recording the results, analyzing them to determine the causes of defects, and redesigning product and process to eliminate those causes.[31] According to a survey of 964 first-tier suppliers, 16 percent of the 453 respondents provided that kind of information to their customers in 1984, while in 1989 the share had increased to 92 percent.[32] There had also been a significant increase in the number of visits by representatives from the assembler to the supplier in order to provide technical assistance. Finally, the majority of suppliers had become responsible for at least part of the design of their product, as opposed to using customer-provided blueprints and specifications. The specific arrangements varied from suppliers performing all the research and design to the customer and supplier contributing equally. Only 5 percent of the respondents in the survey said they had no design responsibility.

TABLE 3

Suppliers providing the following information to assemblers
(percent)

	1984	1989
Statistical process control charts	16	92
Breakdown of production costs	3	19
Production scheduling	50	78
Breakdown of production steps	39	75

Source: Helper (1991).

The importance of quality

Much of the increased information exchange between assemblers and suppliers is motivated by the assemblers' desire to reduce production costs by having suppliers share the responsibility for quality control. To this end, assemblers have given suppliers the tasks of testing parts and components and certifying that they meet the assemblers' specifications. In turn, suppliers have retrained their employees, upgraded their equipment, and worked to make their own suppliers comply with the more demanding standards. Not surprisingly, quality has become more important to the selection of supplier companies; according to one study, it moved up from the third most important criterion in awarding contracts in 1984 to the first in 1989.[33] Performance to quality standards has become very important for continuing a supply relationship over time. Assemblers closely monitor their suppliers' quality records and dependability, with the understanding that continuous high production quality will lead to continuing relationships. Every major auto manufacturer now

bestows quality awards to recognize its top supplier companies.[34]

Contract duration

In a lean manufacturing environment, supplier contracts frequently extend over the particular model's lifetime. For example, when Chrysler made sourcing decisions for the production of its Neon, rather than putting contracts out for bid, the company awarded lifetime contracts to suppliers that met a given target cost.[35] In the five years between 1984 and 1989, the average length of written sourcing contracts in the U.S. auto industry doubled.[36] During the same period the percentage of contracts written for more than three years rose from 4 to 40 percent. Helper also reports that the percentage of suppliers doubled who said their customers would help them rather than switch if a rival supplier came up with a superior product.[37] This finding is consistent with the reported increase in single-source contracts. Not only does it make sense for an assembler to strengthen its reduced number of supplier relationships; a commitment to a long-term contract also serves as an incentive for the supplier company to take on the increased responsibilities described earlier.

Outlook and public policy implications

The above analysis suggests a compelling momentum toward a system of longer supply relationships based on mutual commitment. However, evidence from individual companies does not always square with that picture. That is because complex adjustment is required to change organizational structures and approaches that worked well in the past, as did the Fordist system of production. There is ample evidence of the stress this adjustment causes, and not every company deals with such stress equally well. For example, Helper (1991) reports cases where a manufacturer threatened to cut off suppliers that did not provide the new services such as product design and just-in-time delivery for free.[41] It is unclear how frequently such situations occur, but there is ample evidence that auto assemblers and suppliers can more smoothly implement this more efficient way of doing business with each other. For example, Chrysler has integrated suppliers into its planning process by making them full-fledged members of its vehicle platform teams. About 300 supplier personnel have offices in Chrysler's Tech Center, where the company develops its vehicles. In September 1989 Chrysler began a program to reduce sup-

The new auto supplier: Lean manufacturing from a supplier's point of view

Lear Seating Corporation, based in Southfield, Michigan, is one of the largest independent suppliers of seat systems in North America. The company switched to lean manufacturing in 1984. Its sophisticated just-in-time system enables it to deliver products to a customer's factory on as little as 90 minutes' notice. As soon as the vehicle body leaves the paint shop in the assembly plant, its seating specifications are electronically sent to a Lear plant, where the seats are assembled and loaded for delivery. The company counts 16 auto assemblers among its customers. It currently operates 25 plants, with three more slated to open soon.[38] All of these plants are located near the customers' assembly plants to reduce turn-around time from order to delivery.[39]

Freudenberg-NOK was established in 1989 as a partnership between Freudenberg & Company of Germany and NOK Corporation of Japan to serve the North American market. Headquartered in Plymouth, Michigan, the company employs 3,600 employees in its 14 North American facilities and produces seals, molded rubber and plastics, and vibration control products. Lean manufacturing techniques have given the company significant competitive advantages in terms of cost, quality, and service. Freudenberg-NOK doubled sales during the past five years, while North American auto production was declining by 20 percent. To pursue its lean strategy further, in 1992 the company launched a program called GROWTTH ("get rid of waste through team harmony"), which fosters ongoing, employee-driven efforts to use space, people, and materials more efficiently without adding jobs or floor space. According to the company's president, early results are encouraging. Cycle times have fallen by 82 percent, product lead time by 46 percent, and inventories by 77 percent, while productivity has risen 48 percent and the company needs 44 percent less production space.[40]

plier-related production costs; it has since received almost 6,000 ideas from suppliers that generated $400 million in annual savings.[42] Lean manufacturing sourcing relationships such as these have developed throughout the manufacturing sector; in fact, they are also spreading to areas such as retailing and services.[43]

From a public policy perspective, the introduction of lean manufacturing raises the question of whether the necessary skills will be available at both assembler and supplier companies. Lean manufacturing seems to have raised the educational requirements for jobs in the auto industry. For example, 97 percent of hourly employees that Ford hired between 1991 and 1993 were high school graduates. That compares to about 81 percent for all of Ford's hourly employees.[44] Changing demands for workers' skills might become more noticeable soon, since the average age of an assembly worker in today's auto plants indicates retirement shortly after the year 2000. A number of assemblers are setting up their own supplier support and training programs; here and there, suppliers of one assembler have begun cooperating to pursue a competitive edge and share research.[45] Some have proposed state or regional involvement, for example, to promote technology centers that could transfer the required skills to workers in parts and assembly plants.

Some have suggested building a local economic development strategy around a lean manufacturing scenario.[46] For example, the state of Alabama offered significant financial incentives to attract Mercedes' first North American auto plant, suggesting that the state expects to benefit from supplier employment it assumes will be generated near the assembly plant. However, one needs to analyze the evidence carefully in order to evaluate the regional distribution of benefits and costs of lean manufacturing activity.

Summary

The previous discussion outlined in broad strokes the current trends in the supplier industry and the relationship of that industry to downstream customers. The adjustment process is still under way. The introduction of lean manufacturing has brought with it an increase in outsourcing, the elimination of multisourcing in favor of single sourcing, tiering of the supplier structure, a reduction in the number of first-tier suppliers, and longer-term contracts between suppliers and assemblers. In a lean manufacturing environment, assemblers and first-tier suppliers tend to have close working relationships.

Successfully implemented lean manufacturing sourcing relationships, as described above, enable both parties to benefit from the incentive advantages of longer-term contracts. The assembler can save monitoring costs and cut down on inventory; the supplier is no longer exposed to the risks and costs of annual contract bidding. Under Fordism, assemblers typically had short-term, arms-length relationships with multiple suppliers, relationships not designed to reward commitment.

NOTES

[1]The Fordist system is named after Henry Ford, who introduced interchangeable parts and the moving assembly line to the manufacturing process. Lean manufacturing is also frequently referred to as just-in-time manufacturing.

[2]In developing the lean manufacturing system, Japanese companies, most notably Toyota, were influenced by their own analysis of the Fordist system as well as by the quality-enhancing ideas of the American consultant W. Edwards Deming.

[3]See, for example, Milgrom and Roberts (1990), Helper (1991), Bechter and Stanley (1992), and Klier (1993). The recent gains in market share by the Big Three may well be related to strong gains in manufacturing productivity that occurred during the last few years. For example, Chrysler's remarkable recent success in developing cars quickly and efficiently is reported to be the result of reorganization efforts patterned on development and production techniques employed by Honda. In addition to the automotive industry, applications of lean manufacturing are reported for the consumer and electronic goods, metal products, aircraft, aerospace, and computer industries; see Hollingsworth (1991).

[4]The Midwest is defined as the states of Illinois, Indiana, Michigan, Ohio, and Wisconsin. Currently, about 500,000 workers are employed in auto assembly in the Midwest. When suppliers and related industries are added, the number rises to over 1.25 million (Ballew and Schnorbus 1994).

[5]Ballew and Schnorbus (1994).

[6]U.S. International Trade Commission (1987), p. 3-2.

[7]Automotive products can be found in over 20 additional four-digit SICs. In addition, not all output classified within a particular SIC is necessarily produced for automobile assembly; for example, SIC 3519 encompasses all internal combustion engines. Nor can census data distinguish between supplies to the assembly process and to the so-called aftermarket—items sold to consumers through retail or service outlets.

[8]For an overview of the major changes since World War II, see Ballew and Schnorbus (1994).

[9]These operations are either subsidiaries of Japanese supplier companies or joint ventures, usually of U.S. and Japanese companies.

[10]Estall (1985), p. 130.

[11]Mair et al. (1988). The authors analyzed 12 transplant assembly plants and about 250 transplant parts factories. Practically all of them were greenfield sites.

[12]This pattern is almost entirely absent from the Japanese transplant system. See McAlinden and Smith (1993), p. 38.

[13]Rubenstein and Reid (1987), Rubenstein (1988).

[14]Rubenstein (1988), p. 290.

[15]The number of distinctive platforms built in North America increased considerably, reducing demand for each particular model. Platform refers to the structural underbody of a car. The vehicles that share a particular platform have the same wheelbase and other dimensional characteristics and thus can be produced relatively easily on a common line (Luria 1990, p. 143).

[16]See Glasmeier and McCluskey (1987).

[17]Womack et al. (1990), p. 146.

[18]Helper (1991), Aoki (1988).

[19]Aoki (1988), p. 204.

[20]The tiering effect would not be detectable in the census SIC data since those data do not distinguish different tiers of suppliers. In fact, a shrinking base of first-tier suppliers may well be consistent with the observed increase in the overall number of supplier establishments (see McAlinden and Smith 1993, p. 29). The change toward a tier structure might have led to an increase in the number of second- and third-tier establishments, overcompensating the reduction in first-tier supplier establishments.

[21]Fleming (1993c).

[22]"Ford stands by CDW27 program" (1994).

[23]Chappell (1994).

[24]In a way, this decentralized sourcing structure is similar to the organization of work in the lean manufacturing assembly plant: As work teams require workers to take on wider roles, first-tier suppliers are required to play wider roles as well.

[25]See Treece (1992).

[26]Klier (1994).

[27]Klier (1994). The study estimated an econometric model; in it the variable measuring mutual commitment was statistically significant in explaining a reduction in the probability of vertical integration. The average value for that variable is reported as 2.68 years. Even though no direct comparison to pre-lean manufacturing data is possible, it seems reasonable to expect that number to be lower in a system that relied mainly on annual price bidding.

[28]Ward's Communications (1992), p. 53.

[29]Womack and Jones (1994).

[30]Helper (1991).

[31]Helper (1991), p. 27.

[32]Helper reports that the survey was mailed to "virtually every domestically owned first-tier automotive supplier in the U.S."

[33]Helper (1991).

[34]While these awards tend to favor large suppliers who are able to muster sufficient resources to produce the very best quality, see Treece (1992) for a brief description of four small suppliers that earned quality awards from at least two of the Big Three and also from one Japanese transplant.

[35]Ingrassia and Lavin (1993).

[36]Helper (1991).

[37]Helper (1991).

[38]In April, Lear Seating announced its decision to build a seat plant in Hammond, Indiana, to manufacture seats for Ford's Torrence Avenue auto plant in Chicago, less than 25 miles away (Maclean 1994).

[39]"Supplier profile: Lear Seating targets European market" (1993), and Simmons (1994).

[40]Fleming (1993b), "Supplier profile: Lean production keys growth at FGNP" (1993), and Treece (1993).

[41]In a recent survey of supplier companies, GM's supplier relations were ranked worst among 12 auto manufacturers with plants in North America. This fact seems mostly due to the aggressive cost-cutting approach taken by GM's former purchasing czar, Jose Ignazio Lopez (Gardner 1993).

[42]Bohn (1994).

[43]"Tying the knot" (1994).

[44]Templin (1994).

[45]For example, 24 mostly small parts companies formed such a strategic alliance in Michigan (see Chappell 1993).

[46]Mair (1993).

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