A single automobile is made up of more than 30,000 parts, according to reports. But that number could swell if, in the case of a part that is itself assembled from ten smaller pieces, we count it as ten parts rather than one. The procurement departments of automobile makers know how many pieces they take delivery of, but they count as single items parts that are made up of smaller items. One auto designer has told me that his company is trying to reduce the number of parts that it takes delivery of.\(^1\) One method of achieving a reduction is to have suppliers that deliver parts directly to the final auto assembler, first assemble simple parts into module parts in their own factories prior to delivering them to the final assembler. Meanwhile, however, there is a trend to have many functions added on to an automobile. As a result, even if we suppose that more and more parts will be made into modules, the number of modules will not fall that drastically. Furthermore, the makeup of individual module parts has become more and more complicated, so much so that it is possible

\(^1\) Interview with Manabu Morisaka, head of the Second Planning Division, Second Development Center, Toyota Motor Corp., on 4 December 2001.
that, if we count a module as ten rather than one, the number of parts in an automobile has actually increased rather than decreased.

Auto parts are not just incredibly numerous. They also come in many different sizes. The body of an automobile is punched out of a single steel plate, using a huge press. So the body is one part. At the opposite end of the spectrum you have tiny screws used in the assembly of some electrical part; each of these screws is also one part.

In addition, there are a large number of different materials used in the parts. When autos were first invented, they were a mass of iron. Gradually, however, other materials were introduced in order to allow for greater safety and comfort. Besides metals like iron, aluminum, or alloys of these two, synthetic resin and many other materials have been developed for use in automobile parts.

Since the 1980s a large amount of research has accumulated in regard to the supplier system in the automobile industry, in order to understand the division of labor involved in the development and production of such an enormous number of parts of so many different sizes and materials. These studies have shown that Japan's auto industry has a division of labor structure that is very different from what is found in the West, and that this was contributing to the competitiveness of Japan's auto industry. Still, most of the studies deal principally with the auto makers and the primary suppliers that delivered parts directly to them; there really have not been sufficient studies of the supplier system as a whole, including within the picture secondary and tertiary suppliers.

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3 Thus, for example, while in Japan the number of parts makers that an automobile manufacturer deals with ranges from 200 to 300, in the United States the number ranges from 2,000 to 5,000. Also, it has been pointed out that in Japan parts makers form a three-tiered structure of primary, secondary, and tertiary suppliers, while in the U.S. the structure is a flat one that goes as far as secondary suppliers at the most.

4 Takahiro Fujimoto, Shōichirō Sei, and Akira Takeishi, "Nihon jidōsha sangyō no sapuraiyā shisutemu no zentaizō to sono tamensei" [An overall view of the supplier system in the Japanese automobile industry and its multifacetedness], in Kikai keizai kenkyū [Bulletin of the Economic Research Institute, Japan Society for the Promotion of Machine Industry], no. 24 (1994) and Takahiro Fujimoto, Seisan shisutemu no shinkaron—Toyota jidōsha ni miru soshiki noryoku to sōhatsu purōsesu [A production system theory of evolution: Organizational capacity and emergent process as seen in Toyota Motor Corp.]


In this paper I propose to show, by tracing the pattern of the transactions of Toyoda Iron Works Co., Ltd. (a primary supplier that delivers pressed parts to Toyota Motor Corporation), how the secondary and tertiary parts suppliers that form an industrial cluster in the vicinity of Toyota City are involved in production within the auto industry through a division of labor. I also propose to show, albeit with a limited number of cases, how such secondary suppliers were founded and what their subsequent history has been. In doing this I hope to show that the industrial clustering supporting a flexible production system in the automobile industry was stimulated by the rapid expansion of passenger car production from the mid-1960s and the establishment and development of Toyota’s production method, whose core is the just-in-time principle.

The paper is organized in such a way that Section 1 will give a general outline of how the final assembly process works at Toyota Motor Corporation, which controls the entire supplier system, and it will examine the way in which this is connected with the formation of industrial clustering in the Toyota City region. Next, Section 2 will analyze Toyoda Iron Works Co., a representative primary supplier of pressed parts. In Section 3 an analysis will be made of suppliers to Toyoda Iron Works (and thus secondary suppliers of Toyota Motor Corp.).

Before proceeding to Section 1, I would like to explain briefly why attention is paid to pressed parts. The first reason is that the technique of molding by means of pressing machines is the most suitable means of molding a large variety of parts at a low cost, and it is the most frequently used basic technique in the manufacture of auto parts. The second reason is that the most suitable type of pressing machine is

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(Yūhikaku, 1997) conduct analyses of the multilayered nature of the supplier system, using as a basis for their research the results of a questionnaire survey carried out in August 1992 among 1,500 offices of auto industry companies in Kanagawa Prefecture (of which only 120, or 8%, responded to the questionnaire). From their research it is clear that parts makers form a multilayered pyramid of primary, secondary, and tertiary suppliers, but they point out that “when one looks closely at the business dealings, one finds that sometimes primary suppliers reverse the normal flow and supply secondary suppliers, and sometimes secondary suppliers bypass the primary suppliers and deliver goods directly to the auto maker, and so the structure becomes complicated.” They also point out that “there is a huge difference in scale and technical capacity between primary and secondary suppliers, while between secondary and tertiary-and-lower suppliers there is a difference in regard to instability in business relationships.”
determined on the basis of the shape (including the size) of the part to be pressed and on the basis of the size of the lot to be manufactured.\(^5\) A single pressing machine cannot be used to manufacture all the pressed parts in an automobile. There is a limit, however, to the types of pressing machines that can be installed in any one factory, so the multiformity of pressed parts is closely linked with the division of labor structure, especially its multilayeredness. The third reason is that this technique is often combined with other essential techniques such as welding, plating, painting, heat-treating, and die making; this also is closely connected with division of labor structure, especially industrial clustering in the Toyota City region.

1. THE FINAL ASSEMBLY PROCESS AT
TOYOTA MOTOR CORPORATION: THE MOTOMACHI PLANT

Toyota Motor Corporation, Japan's most representative auto maker, owns twelve plants (fifteen if one includes 100%-Toyota-financed subsidiaries) within Japan. Five of these are assembly plants, the other seven are parts manufacturing plants. The oldest of the plants is the Motomachi Plant, built in Toyota City in 1959 as the first passenger vehicle assembly plant.

Observations at the Motomachi Plant

The Motomachi Plant does the pressing, welding, painting, and assembling processes within the confines of a plant that covers 1,600,000 square meters of land. Here are assembled middle-class passenger cars such as the Crown, to the tune of 13,000 or so vehicles a month. For a factory that assembles finished automobiles to have at the same time the body manufacturing process is normal practice.

In the pressing process, molding of auto bodies is carried out

\(^5\) Pressing machine technology has evolved from tandem presses through fine blanking presses to transfer presses. A tandem press is operated manually by a worker, and it forms the shape of a part in a single action, or “shot.” A fine blanking press forms the shape of a part out of a sheet of steel that is automatically conveyed to the press, in a series of several “shots.” This specialized press is reported to have been developed around 1960. In a transfer press, several pressing machines are combined in a single line, and as a sheet of steel is automatically conveyed from one pressing machine to the next, the shape of the part is formed. Toyota Motor Corp. introduced its first transfer press line, a fully automated 2,000-ton transfer press, in 1984.
automatically in a 2,000-ton transfer press line. The body manufacturing process up to around 1960 consisted in cutting out each steel plate one at a time with a shearing machine, measuring it with gauges, forming it into shape by means of a tandem press, and then finishing it with hammers. From around 1960, when mass production of the Crown began, this process was quickly turned into a line process that was automated.6

The body is sent on to the next stage, the welding process, where about 400 body parts are welded onto it. Once all this is done, the outside shape of the automobile is more or less finished. Next it is sent to the painting process, where electrodeposition is done, and now it begins to look like an automobile.

Next it is sent to the assembly section, where assembly takes place on a belt conveyor. To the side of the belt conveyor is a ready supply of the parts that will need to be attached in various individual assembly operations. There are about 2,500 such parts, brought in from 120 different companies. These parts are all delivered in accord with the just-in-time idea, which is: “In order to do away with stocks between processes and do away with excessiveness, unevenness, and wastefulness, and to enhance production site efficiency, only what is needed, when needed, and in the amount needed.” Deliveries are controlled in such a way that no parts are stored in the storage boxes near the assembly line except in quantities required for the time being. This idea of just-in-time is attributed to the words of the founder of the company, Kiichirō Toyoda, who is reported to have said, “It is best to collect the auto parts just in time.” As a control tool to bring about this just-in-time principle, use is made of a kanban—a square card that is inserted into a vinyl bag. On each kanban are written the questions “What, and how much is wanted?” or “What, and how is it to be made?” These kanban are used even for parts contracted out; they began to be circulated to some of the primary suppliers in 1965.7

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Also, parts delivered by parts suppliers are used without each item having to undergo a preliminary inspection. This is because all of the parts suppliers have accumulated experience in making their respective parts, their technical abilities have improved, and their reliability has been proven. The important thing is that the Motomachi Plant was not able to reduce the cost of monitoring parts until the technical abilities of the parts suppliers delivering parts to it had improved as a whole.

Each vehicle being assembled on the belt conveyor differs in detailed specifications, even if it is part of a series of the same make of automobile. These detailed specifications are written on an instruction sheet pasted to the body of the car during the assembly process. In accordance with the instructions on this sheet, workers on the assembly line add on parts chosen from a large number of different parts. Even “system parts” like seats or engines, which are themselves already assembled from a large number of parts, differ in specifications one from another, so only the parts that satisfy the requirements listed on the instruction sheet are brought in and lined up next to the assembly line. This is called “sequencing,” and it is a necessary step in the “single-unit production and conveyance” that is an important element in just-in-time production. When the parts supplier is located close to the assembly process, “sequencing” is carried out in the supplier’s factory. This means that a parts supplier that is located near the assembly plant has a competitive edge over other suppliers because it can carry out sequencing in its own factory and then deliver the item accordingly.

A Few Reflections on the Formation of an Industrial Cluster

In response to the growth in demand for passenger cars from the mid-1960s, Toyota Motor Corp. went on building new plants: the Takaoka Plant in 1966, the Tsutsumi Plant in 1970, the Tahara Plant in 1979, and the Miyata Plant owned by Toyota Motor Kyūshū, Inc. in 1992. The Motomachi, Takaoka, and Tsutsumi plants were located very close to one another in Toyota City (less than 10 minutes away by motor vehicle). It is clear that this kind of concentration of assembly

8 “Single-unit production and conveyance” became a fixture as a result of a “basic thoroughness” campaign within the Toyota production system that was conducted throughout the entire Toyota Motor Corp. from 1982 to 1985.
plants—in other words, the bringing in of demand for parts suppliers—was one of the key factors stimulating the formation of an industrial cluster of parts suppliers in Toyota City and its environs in the 1970s.

The Toyota production system that was built around just-in-time also began to be developed from 1965 (it was applied to parts suppliers as well), and the fact that this system made it more advantageous for a parts factory to be located near the assembly plant was an important factor stimulating the formation of an industrial cluster. For it meant that parts suppliers were asked to deliver to the assembly plants parts in small lots and with more frequency (at least once a day, and sometimes two or more times a day in the case of parts that were used in great numbers). It is obvious that in such a situation being located near the assembly plant would be more favorable to a parts supplier. The same thing can be said when "sequencing" was carried out.

2. TOYODA IRON WORKS CO.

Now let us look at Toyoda Iron Works Co. (hereafter, Toyoda Iron Works), a representative primary supplier of pressed parts to Toyota Motor Corp. We begin with a summary of what the company does and of its history, then go on to a description of the division of labor among the company's different plants, and a description of their business relationships.

Summary of Operations and History

Toyoda Iron Works is an unlisted company capitalized at 2,223,000,000 yen, with about 2,000 employees. Toyota Motor Corp. owns 49% of its shares, and three retired Toyota Motor Corp. officials are directors of the company. Its principal products are body parts molded by pressing machines, plastic molded interior parts, and chassis parts produced by assembling several pressed parts, such as brake pedals and foot parking brakes. It has three plants in Toyota City located within a ten-minute drive from three of Toyota Motor Corp.'s assembly plants: the Main Plant, the Hirokute Plant, and the Sasahara Plant, plus another (the Nukada Plant) located in Nukada-
chō, a township not far from Toyota City. In addition, in Kyūshū it has a 100%-owned subsidiary in Wakamiya-chō, not far from the Miyata Plant of Toyota Motor Kyūshū, Inc. The name of this subsidiary is Toyotetsu Kyūshū Co., and it assembles pressed parts.

In 1946 the company was established with a capitalization of 1,000,000 yen put up jointly by Kato Iron Works Co. (located in Mizuho Ward in Nagoya), Koromo Aircraft Components Manufacturing Co., and Toyota Motor Co. (as it was then known), and it was called Koromo Iron Works Co. Since Koromo Aircraft Components Manufacturing Co. had just been established shortly before the end of the war and as yet was not producing anything, it was Kato Iron Works that was the real core of the company. Kato Iron Works had been producing pressed parts for the automatic looms produced by Toyoda Automatic Loom Works, but when Toyota Motor Co. was established it started producing parts for automobiles as well. With the aim of grooming Kato Iron Works into an auto parts maker, Toyota Motor Co. used financial leverage to revamp it as Koromo Iron Works Co. In 1959 the name was changed to its present name of Toyoda Iron Works.

As I indicated in the beginning of this section, this company has close financial and personnel ties with Toyota Motor Corp., but it has not always enjoyed smooth sailing. To keep in step with increases in production at Toyota, the company has added to its production equipment five times over the eight-year period 1955–62. By 1963 it had grown to the extent that it specialized in making brakes, and it took on the responsibility of supplying more than half of the brakes for Toyota autos. In addition, in 1962 it took on other customers besides Toyota: Honda Motor Co., Suzuki Motor Corp., and others. But when production at Toyota suddenly increased in 1967, Toyoda Iron Works was unable to keep up with orders and fell behind in deliveries to Toyota. The latter took the opportunity to review its brake supply arrangements, and the result was the establishment, at Toyota’s initiative, of Hōsei Brake Industry Co. by a group of four companies: Toyota, Akebono Brake Industry Co., Aisin Seiki Co., and Toyoda Iron Works. At this time the Brake Division of Toyoda Iron Works, including both its equipment and its personnel, was transferred to Hōsei Brake Industry Co.

No longer a brake manufacturing specialist, Toyoda Iron Works
turned itself into a general manufacturer of pressed parts, expanded the range of its products, and grew to its present size.

Division of Labor among Its Plants

The company's Main Plant began operations in 1970. Using an integrated production line that includes pressing, welding, painting, and assembly, it produces chassis parts such as parking brake levers and brake pedals. By way of large pressing equipment it has, in the second half of the 1980s, brought in 1,000-ton transfer and 600-ton blanking presses. The feature of this plant is "multiple-type mixed-flow production," in which each worker produces on average ten different types of parts. It produces 120 types of parking brake levers (its principal product) and holds 30% of the domestic passenger-vehicle market share for this item. When it comes to the foot parking brake, it and Aisin Seiki each hold a 50% share of the market.

The Hirokute Plant is the oldest of the company's plants, having begun operations in 1963. It is made up of a manufacturing division and an industrial machine division. In the former it uses an integrated pressing, welding, painting, and assembly production line to produce smaller items than those produced at the Main Plant. It has 850-ton and 300-ton transfer presses and 250-ton and 200-ton blanking presses, which are smaller than those used in the Main Plant and the Nukada Plant. In the industrial machine division it makes use of the latest CAD and CAM technology to design and make dies for pressing and dies for resin. Besides producing dies for use within its own plants, it also designs and makes dies ordered by Toyota Motor Corp. and by overseas buyers. Designing is done completely within the company, but a portion of the manufacturing has to be contracted out. About 50% of the dies used within the company are produced in-house. For a pressed parts supplier, dies are a lifeline. It is particularly difficult to find a maker specializing in dies that can make dies for use in large pressing machines that exceed the 1,000-ton size. The more varied the type of product produced, the larger the number of dies needed. So Toyoda Iron Works produces in-house the large dies that it cannot find another company to contract the work out to, and it contracts out the smaller dies that other companies can make. The company began making pressing dies in-house in 1955, but it was not until the mid-1960s—when the Toyota production system with its
just-in-time philosophy was introduced among Toyota parts suppliers as well—that it went into all-out in-house production of dies by building an industrial machine factory.

The Sasahara Plant, which began operations in 1985, specializes in plastic molding. It produces door trim and other interior parts. The Nukada Plant, opened in 1991, is a new and advanced plant equipped with a 2,000-ton transfer press. It produces larger-body parts such as the radiator support assembly.

We can generalize from the above data to say that the more recently the plants began operating the larger their pressing equipment has become. From this we can infer that, as Toyoda Iron Works has grown larger, it has shifted the range of its products to larger-sized pressed parts requiring larger equipment, and that it tends to contract out small pressed parts.

**Business Relationships: Who Supplies Whom?**

Toyoda Iron Works is regarded as the primary supplier of the Toyota Motor Corp. Seventy percent of the company's products are delivered directly to Toyota Motor Corp.'s five auto assembly plants. Three of the latter (Motomachi, Tsutsumi, and Takaoka) are only a short distance away from the company's plants (at most 30 minutes away by motor vehicle). This is convenient for frequent delivery of small quantities of parts; every day, delivery trucks make about 150 trips from the Main Plant's truck yard to deliver goods to customers.

Until Toyotetsu Kyōshū Co. began operations in 2000, the company was trucking parts that had been assembled in its plants in Toyota City to the Toyota Motor Kyōshū Co.'s Miyata Plant during the eight years from the latter's establishment in 1992. But transportation costs end up high when you transport pressed parts after they have been assembled, because then you are, as it were, transporting air. Toyota said transportation costs would be too high a proportion of the total cost and asked Toyoda Iron Works to incorporate that part of the cost into calculating the purchase price. This prompted the company to establish the 100%-owned subsidiary Toyotetsu Kyōshū in 2000, and it built a factory where fifty people could work in a location not far from the Miyata Plant. No presses were installed; they had single parts transported from the Tōkai region and used contracted-out labor to assemble the parts.
The company also supplied parts to other companies (besides Toyota) that handled assembly processes for Toyota: Kantō Auto Works, Toyoda Auto Body, and Daihatsu Motor Co.

From the Hirokute Plant pressed parts such as front seat cushion frames are also supplied to Araco Corp. and Takashimaya Nippatsu Kōgyō (both primary suppliers of Toyota Motor Corp.). Thus, if we apply the usual definitions of the terms, the company is not only a primary supplier of Toyota but at the same time a secondary one, since it supplies some of Toyota Motor Corp.’s other primary suppliers.

The trend in the last three or four years is towards modules and systems. A large number of parts are first assembled by a certain primary supplier prior to being delivered to Toyota’s assembly plants. As we saw in the case of Toyoda Iron Works, where these parts are concerned it is regarded as the primary supplier, while for other parts it is considered a secondary supplier. As more emphasis is put on modules and systems, we shall have to accept the fact that the meaning of the distinction between primary and secondary supplier is different from what it used to be.

*Business Relationships: Drawings from Toyota*

The technical drawings, or plans, that Toyoda Iron Works uses when it manufactures pressed parts that it supplies to Toyota Motor Corp. can be roughly divided into two types. The first type is referred to as approved drawings, or drawings that Toyoda Iron Works has produced and that Toyota has approved. Brake pedals and other functional parts are usually made from approved drawings. The second type is drawings that are provided by Toyota, and these are called supplied drawings. A portion of the supplied drawings are produced by “guest engineers” sent from Toyoda Iron Works to Toyota’s Technology Division (where products for new automobiles are designed). Recently there is a tendency for this type of drawing to increase. Most of the time the production of parts whose drawings have been produced by guest engineers will be contracted out to the companies to which the guest engineers belong.

Often a note is added to a drawing, saying “fitting.” This means: “What is written on this drawing notwithstanding, this is to be adapted to the larger part to which it is attached” (for example, a body produced at a Toyota plant). In a product such as an automobile, in which
huge numbers of parts are combined in complex fashion, not all the necessary information is always given on the drawing. Before the company proceeds to mass production, a careful exchange of information among all those responsible for the various parts that are to be assembled is very valuable when done on-site. Toyota Motor Corp. and Toyoda Iron Works carry out an exchange of information not only between their engineers but even between workers on the site, as a result of which the latter company has earned a reputation for being "good at fitting." For this kind of close rapport to occur, geographical proximity is a vital factor.

3. TOYODA IRON WORKS' SUPPLIERS = TOYOTA MOTOR CORP.'S SECONDARY SUPPLIERS

Companies that Toyoda Iron Works directly orders supplies from on a continuing basis are the 33 companies listed in Table 1. If we define secondary suppliers as companies that provide parts or services to primary suppliers, then these correspond to secondary suppliers.

The average capitalization of these 33 companies is 18,120,000 yen, and the average number of workers they employ is 49; they can with justification be categorized as middle-scale small businesses. Nine of them are pressing/welding companies (this includes one that does only welding); this is the largest single category, which is followed by 8 companies that make dies. Four do trial manufacturing, 3 do painting, 3 do cutting, 2 do heat treatment, 2 do resin processing, 1 does plating, and 1 does aluminum die casting. Thus the makeup of the company's suppliers covers a very wide spectrum. If we look at where they are located, we see that 14 (42.4%) of them are in Toyota City, 9 (27.3%) are in adjacent cities/towns, and 10 (30.3%) are located elsewhere. The ones that are located in the slightly more distant

9 Table 1 was compiled by me from information I received in an interview with Shinsuke Kondo, head of the Human Resources Development Office in the General Affairs Division of Toyoda Iron Works on 12 November 2001. In accordance with an agreement made during the interview, the names of the companies have been replaced by code names. I visited the following companies personally: "A1" on 7 Aug. 2001, "A1"'s supplier "a1" on 27 Aug. 2001, "F1" on 22 Oct. 2001, "J1" on 22 Oct. 2001, and "J2" on 21 Oct. 2001. Most of the information contained in this Section 3 is based on what I learned during these visits.
places are some that belong to the pressing/welding, cutting, resin processing, and die making categories.

In this section I propose to present outlines of the 4 companies in this list of 33 that I personally visited, their histories, and their business relationships, and do the same for a fifth company (not on the list of 33). The companies were “A1,” a pressing/welding company; “a1,” another pressing/welding company to which “A1” was contracting out the production of some pressed parts; “F1,” a plating/painting company; “J1,” a die maker; and “J2,” another die maker.

Pressing/Welding Companies

This category of business is the same as the one Toyoda Iron Works belongs to: the manufacturing of pressed parts. Of the 33 companies listed in Table 1, nine belong to the pressing/welding category. They manufacture small pressed parts, using pressing machines that for the most part are smaller than Toyoda Iron Works pressing machines. All of them are located near a Toyoda Iron Works plant (within, say, a 15-minute drive). The policy that is followed when Toyoda Iron Works places an order for pressed parts is that, first, it must order a part that can suitably be made by that company’s pressing machines, and, second, consideration must be given not to overburden the supplier.

“A1”

Summary Description and History

“A1” is a medium-sized, family-owned company of 65 employees, with capitalization of 13,000,000 yen. It has no financial ties with Toyoda Iron Works, and none of its personnel is from Toyoda Iron Works. It is located in Toyota City, not far from Toyoda Iron Works’ Hirokute Plant (a five-minute drive away).

The father of the present president of the company founded it in 1964 when he was employed as an instructor in a driving school. One of the present president’s uncles took over as the second president of the company. After the present president graduated from university he went to Toyoda Iron Works for four years of training, during which time he learned about dies and welding, and later he took over as the third president of the company. He says, “Toyoda Iron Works takes on the education of people who will follow on in the manage-
### Table 1. Companies to Which Toyoda Iron Works Consigns Work

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<th>Code name</th>
<th>Type of Business</th>
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<td>J2</td>
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<td>10</td>
<td>Nishibiwajima-chō, Kasugai-gun</td>
</tr>
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<td>Die Making</td>
<td>10</td>
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<td>Osaka City</td>
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<td>Tōgō-chō, Aichi-gun</td>
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...ment of a company, and they take good care of a person. Some of my colleagues and superiors who were with me then are still at Toyoda Iron Works, so another aspect is that there is good rapport between us and them. In a sense, then, Toyoda Iron Works can be said to play a sort of incubator function.

The factory is equipped with a range of pressing equipment, from...
FIGURE 1. Aichi Prefecture

- □ Toyota Motor Corp. plant
- ○ Toyoda Iron Works plant
- △ Secondary supplier's plant
300-ton mid-scale blanking presses to 25-ton small-scale tandem presses. In comparison with Toyoda Iron Works’ pressing equipment, its presses are small, but the special feature of the company is the variety in the size of its presses. This is in stark contrast to Toyoda Iron Works, which has gone in for larger presses since the second half of the 1980s. Toyoda Iron Works places orders with “A1” for small pressed parts of comparatively simple shape that can be made by blanking presses—parts that are not suitably made by Toyoda Iron Works’ own huge presses. Another feature of “A1” is that it has a large variety of welding equipment that balances well with its presses. As a result, it has the capacity to weld in quick order within its own factory pressed parts that it has produced itself. So it is a pressed parts supplier that is capable of a short turnaround period.

**Business Relationships**

The company makes specific production plans on the basis of unofficial instructions that come from Toyoda Iron Works at the end of each month. The kanban method that is so vital an element in the Toyota production system has been introduced into the company and production and stock control is carried out. This shows that production is synchronized with Toyota Motor Corp. and Toyoda Iron Works. Orders come from Toyoda Iron Works in the form of drawings. Still, if a more efficient pressing operation can result from making a slight change to the drawing, “A1” sometimes suggests changes in the design to Toyoda Iron Works.

About 10% of the total order “A1” receives, it subcontracts out to four other pressing/welding companies (“a1,” “a2,” “a3,” and “a4”). Later I shall deal with “a1” in more detail, but here I wish to point out that “a1” is about a 30-minute drive away from “A1,” and the other three companies (each employing from 5 to 10 workers) are within an hour’s drive away. “A1” subcontracts out to them items that are so small they need to be pressed by smaller presses than “A1” has, and items that take a lot of time and trouble to make.

The drawings for its press dies are designed in-house and the making of them is contracted out to two companies that are Toyoda Iron Works’ suppliers as well: “J2” (located in Nishibiwajima-chō in Kasugai-gun, a 45-minute drive away) and “J3” (located in Handa-chō in Handa City, an hour’s drive away). Both of them are small-scale businesses employing about ten people each.
Items that need painting or plating are sent by arrangement with Toyoda Iron Works to "Fl," a painting/plating specialist located about a 15-minute drive away. Since Toyoda Iron Works requires that deliveries be made in small lots and frequently, the companies to which it subcontracts work must be located fairly close by.

"a1"

Summary Description and History

This is a small, family-owned company employing 34 people and capitalized at 10,000,000 yen. It is financially independent of all other companies and has no personnel from any other company. Located in Toyota City, it is fifteen minutes by vehicle away from "A1."

The founder of the company (its present president) worked on engineering works at Toyota Auto Body Co. after graduating from high school in Toyota City. After thirteen years of work there, he resigned his job and in 1976, at age 38, started up his own company, "a1," with his wife and three part-time workers helping him. He purchased three secondhand pressing machines. He learned pressing techniques for six months at a pressing company located nearby. Work for his company was supplied by Tōkai Iron Works Co., the vice president of which used to be the man's boss when he was working at Toyota Auto Body.

The pressing equipment at "a1" covers a wide variety within the range of 250-ton mid-scale blanking presses down to 45-ton small-scale blanking presses. The special feature of "a1" technology is its establishment of an automated system in which four tandem presses are lined up in a row and conveyance robots move pieces around. In this way small pressed parts of complex shape can be produced cheaply and quickly without human handling. Some of the dies are made in-house, but only 5%. The company employs two die makers, but most of the time they do maintenance. The company contracts work out to eight companies that specialize in die making; all are located in Toyota City or its environs. It frequently places orders with four of them in particular. These die makers have their own trial presses, so they can adjust the dies in-house before installing them in a pressing company's machines. In this regard, it does not matter if these factories are some distance away. Still, in recent years the development period of a new make of auto has become shorter, and it happens more and more that design changes are being made after drawings have
been made. In such situations, adjustments to the dies and "fitting" become a necessity, hence it is more convenient to have the die maker geographically close. If orders are placed overseas and then there is a change in design, things become extremely difficult. Even if the subcontractor is within the country, but separated by a great distance, turnarounds take too much time.

**Business Relationships**

Companies such as Kyohō Manufacturing Co. and Kojima Press Industry Co., which are primary suppliers to Toyota Motor Corp., are "a1"'s major customers, and such a pattern makes "a1" a secondary supplier to Toyota Motor Corp. The company's dealings with "A1" amount to no more than 10% of all its business transactions, whereas as far as "A1" is concerned "a1" represents an important company with complementary pressing technology. Although at present almost all of "a1"'s work is for Toyota-related companies, earlier the company had done work for Honda Motor Co. and even some work that did not involve auto parts (for example, work done for Matsushita Electric Works).

When "a1" receives an order to make parts for "A1" it is supposed to press the parts in accordance with drawings made at Toyoda Iron Works, but then it becomes necessary for representatives from Toyoda Iron Works, "A1," and "a1" to meet and discuss how to make the interfaces where pressed parts are welded together. In addition to the requirement of small-lot and frequent delivery, this is another point on which the geographic proximity of these three companies is of importance.

Among the companies that "a1" places orders for work with, three are welders, one does painting, and one does plating. All are located within a 30-minute drive from it; all are very small businesses employing about five people each.

**Die Making**

I mentioned earlier that Toyoda Iron Works has in its Hirokute Plant an industrial machine factory to make dies, and there the company makes 50% of the dies it uses, mainly dies for large presses. The other 50% it subcontracts out to the eight companies listed in Table 1. All of these companies have been receiving orders from Toyoda
Iron Works for many years, and they are members of Toyotetsu Kyōeikai, a cooperative association organized by Toyoda Iron Works. Besides these eight, there are ten other companies that Toyoda Iron Works deals with occasionally. These latter are larger companies, companies that can absorb fluctuations in the industry.

Thus dies, which are the lifeline as far as a pressed parts supplier is concerned, are procured in any of three ways: 1) by being produced in-house; 2) by being purchased from die makers with whom one has long-continuing relationships; 3) by being purchased from die makers with whom one occasionally places orders. This is a consequence of the fact that wide fluctuations exist in demand for dies, with hardly any orders for them outside of those times when new models of autos are being developed. It often happens that, just when one pressed parts supplier needs dies, other pressed parts suppliers also need them, and for this reason to a certain extent one has to "keep" a die making specialist in one's own factory who will always be available to meet demand in such a situation.

This has a connection, I believe, with the fact that many of the eight die makers listed in Table 1 are not as geographically close to Toyoda Iron Works as the other categories of businesses. Die making companies that will meet one's demand at any time have to be sought from a wider catchment area (even if convenience has to be sacrificed somewhat) than Toyota City and its environs, where there is such a high concentration of demand for the services of auto parts presses.

"J1"

Summary Description and History

This is another small, family-owned company of 17 employees, with a capitalization of 5,000,000 yen, and no financial or personnel ties with any other company. It is located in Okazaki City, but near the Toyota City border. Its distance from the Toyoda Iron Works Main Plant is about 45 minutes by motor vehicle.

The present president's husband (d. 1997) founded the company in 1977. Because the family of the present president (the widow) were in the business of making dies for automobile presses (it originally had been in the pressing business, but when there was a shortage of labor during the period of high growth it had changed to this business), the founder of the company, after eight years of training in his wife's family's business, set up his own business with his wife.
Their venture started out by receiving work from a large pressed parts maker that had dealings with the wife's family's business. In those days there still were only a few die-making companies around. Their dealings with Toyoda Iron Works began when the present vice president of Toyoda Iron Works, Izuru Takeuchi, happened to pass by, stopped and looked around their shop, and said, "Would you mind trying some work for us?"

In the past three or four years a great change has taken place in die making technology, particularly by the entry into the die designing process of NC (numerical control) technology. To design dies now, personnel who can manipulate a computer in CAD are required. "J1" has two such people. How large of a die can be made depends on how large of a trial press one has. "J1" has a 300-ton and an 800-ton trial press, so it is able to produce dies for large presses up to 1,000 tons in size. Die operators can manage on their own several different operations involved in die making once they have accumulated seven to eight years of experience. At that stage some operators leave and go to other companies. At present, to start up a business in die making a person needs a huge amount of money to invest in equipment, and as a result nobody is starting up such a business.

Business Relationships

The only company from which "J1" receives orders is Toyoda Iron Works. There are crests and troughs in the amount of orders. From 90 to 95% of the orders are for new dies and the remainder are for repair dies. Fluctuations in the demand for new dies cannot be avoided. Toyoda Iron Works strives to provide a stable amount of work in the orders it places for both types of dies. In general the time span between the placing of an order and its delivery date is three months. On rare occasions an order comes in that has to be delivered in half that time. A die maker that does ongoing business with that company makes sure it fills such orders by juggling its other work as well as it can.

Once "J1" has installed its dies in a Toyoda Iron Works plant, fine adjustments must be made before mass production can begin. It is not unusual for a die to make two or three round-trips between Toyoda Iron Works and "J1" for the sake of these fine adjustments. Because of this it is convenient to have both companies in close proximity. Sometimes Toyoda Iron Works has dies made in Korea, Osaka, or Hiroshima, and then it has the fine adjustments done at "J1."
Hardening is contracted out to two companies located in Kariya City: "c1" (a medium-sized business employing 30–40 workers) and "c1" (a small-scale cottage industry run by a person who specializes in hardening only the surfaces of metals using high-frequency waves). The former, "c1," can do work very quickly when needed, taking in an order one day and delivering it before noon of the next day. Since most of the work done in this region is connected with auto parts, and these businesses are all working to short delivery periods, the workers at "c1" are accustomed to working such hours.

The material for the dies is obtained from a Toyota City branch of an Osaka trading company specializing in steel materials. There are so many automobile industry-related users in the Toyota City area that it pays for the Osaka trading company to have a branch established in Toyota.

"J2"

Summary Description and History

"J2" is a small, family business that employs ten workers and is capitalized at 10,000,000 yen. It has no financial or personnel ties with any other company. It is located in Nishibiwajima-cho in Kasugai-gun, about 45 minutes away from the Toyoda Iron Works Main Plant by expressway.

The present president founded the company in 1965. He had worked for a die maker in Nagoya before he started out on his own. This company was a small one of about twenty workers that mostly made dies for insulators to be delivered to NGK Insulators, Ltd. "J2" has a 200-ton trial press and is able to produce dies for presses as large as 250-tonners.

Business Relationships

Seventy percent of "J2"'s work comes from Toyoda Iron Works, and the rest from "A1." The company also sometimes receives orders for Honda-related dies; oddly enough, when Toyota-related orders peter out, Honda-related orders start coming in. When "J2" was first founded, its work consisted almost entirely of making dies for a secondary supplier of pressed parts that was delivering small pressed parts to Futaba Industrial Co. One day it received an order for a die for Toyoda Iron Works through a personal introduction. Its dealings with "A1" began through an introduction from Toyoda Iron Works. (A new business
relationship begins with an introduction by a third party; once a new business relationship begins, it usually continues for a long time.) Orders for dies usually are placed on the basis of past performance—what one has shown one can do. This is because, when the job is for a make of automobile one has experience with, one can apply what one did before to good advantage.

Peaks in orders have increased in number. Overlapping of delivery times has become more frequent. Whereas five years ago production preparation times were from three to six months, recently it has been shortened to from two to three months. When orders overlap and cannot be completed in time within the company, work has to be subcontracted out. Before the subcontractor can begin work there has to be sufficient conferral about what has to be done, and how; because of the care that has to be paid to small details, it is necessary to go to the subcontractor and confer at middle stages as well. For this reason the subcontractor has to be located nearby.

"J2" has four companies to which it subcontracts die-making work, and all of them are within ten to 15 minutes away by car. Hardening is subcontracted to "c3," which is about 30 minutes away by car. Since "c3" regularly makes the rounds of "J2"'s area to pick up items that need to be hardened, "J2" only needs to make a phone call and "c3" will send someone to pick up the goods. A small company of fifteen employees, "c3" is a middle-scale heat treatment business. Because of the concentration of gear and shaft manufacturers in this area, the service that "c3" provides is economically feasible.

Plating and Painting

"F1"

Summary Description and History

A small, family-owned business employing 37 workers, "F1" is capitalized at 10,000,000 yen, and it has no financial or personnel ties with any other company. The head office is located in Shōwa Ward in Nagoya, where it started out in business, but its factory is in Toyota City. It does electroplating and electrodeposition.

The company was founded in February 1947 with funds provided by the father of the present president. The factory was built in what is today Shōwa Ward, on the site where the head office now stands. In its early years it plated bumpers for Occupation Forces vehicles and
did nickel-chrome plating and copper plating of Buddhist altar fittings. Dealings with Toyoda Iron Works began in 1969, with plating of brake levers for the Corolla. In 1970 it built a head office factory in Nagoya City and ran it as a factory for nickel-chrome plating. About this time, in addition to Toyota-related work it was also doing nickel-chrome plating of steel chairs for Houtoku Co. and fenders for Honda Motor Co. motorbikes. When the iron for nickel-chrome plating work was replaced by stainless steel, demand for such work fell, so in 1973 the company abandoned its nickel-chrome plating line and shifted to specializing in zinc plating. By 1983 the Nagoya factory had become too cramped, so in looking for a new site the owners decided on a site in Toyota City near the factories of companies from which it received orders.

In the case of auto parts, the most common objective is the prevention of rusting, whether by plating it or painting it. If one does a cost comparison, in general painting is cheaper, but when the items to be painted are small, painting can be more expensive than plating. As a method of rust prevention, painting can be used to complement plating, and for this reason most such companies are equipped so they can handle orders for both processes.

What a company involved in this type of business has to do is figure out how to make something at less cost without sacrificing quality, and the key to doing this lies in rigging up jigs. Next-door to “F1”’s factory is a shop (employing 13 workers) that makes tin cans, does welding, and makes the low, flat-board trolleys used in automobile assembly plants. Its location is convenient for “F1” because it can make jigs on short notice.

“F1” works on a short delivery period of half a day. A truck packed with finished products leaves every morning to deliver goods and when it returns in the late afternoon it is loaded with materials to be worked on. They are of many different types. Every day the company plates from 500 to 600 items. Some lots are large, some small; a lot might include 10,000 items, or it might include a box of 100 items, or it might even include only three or four items.

Business Relationships

Toyoda Iron Works and Shiroki Corp. (both Toyota Motor Corp. primary suppliers) provide “F1” with most of its orders, but both combined provide only about 50% of its work. Most of the other half of
its orders come from Shiroki Corp.'s parts suppliers (in other words, secondary suppliers of Toyota Motor Corp.). A small portion of its orders comes from an electric tool manufacturer in Okazaki City, but orders from this company have fallen since the latter established a production plant in China.

"F1" subcontracts out about 5% (in monetary value terms) of the orders it receives. It subcontracts nickel-chrome plating to three companies, functional plating of integrated circuit parts to one company, hardening to two companies, pressing to two companies, and assembly to two companies. All of these involve technology or functions that "F1" does not possess or cannot provide. The businesses to which "F1" subcontracts work are not necessarily smaller than "F1."

**CONCLUSION**

As I pointed out in the beginning, a huge number of companies of many different types and kinds are involved in the making of a single automobile. The businesses we have looked at in this paper are from a comparatively very limited region and biased in type towards companies connected with metal pressed parts. But, while acknowledging these limiting conditions, I would like to summarize what the above observations can tell us.

First of all, though assembly is carried out at many stages and out of many components in order to produce an auto, this does not mean that each assembler issues instructions to suppliers at each stage in regard to which companies are to be asked to provide parts or processes. Rather, each of the suppliers at each stage tries to figure out the most efficient way to procure such parts or processes and makes a decision on his own. In other words, the estimated 30,000 parts that go into making up an automobile are not assembled "by fiat from above" but "in a self-organized way."

Secondly, the relationships between assemblers and suppliers at each stage are not (as Fujimoto, Sei, and Takeishi have shown on the basis of the questionnaire survey on auto-related industries conducted in Kanagawa Prefecture) always the simple multilayered vertical division of labor that is expressed by the simple upward progression of tertiary supplier → secondary supplier → primary supplier → assembler. Rather, as business dealings proceed from primary to secondary
supplier, and then on from secondary to tertiary supplier, they become interwoven in more complicated patterns (as we see in the industrial cluster in and around Toyota City). As modulization and systemization of parts progresses even more, we can expect networking to progress as well.

Thirdly, especially as far as we can tell from focusing on pressed parts, it became clear that the shape (and size) of pressed parts and the special character of the pressing machines that produce them are closely connected with the multilayered division of labor structure. In other words, the assemblers and primary suppliers produce large pressed parts by means of large, automated equipment; secondary and tertiary suppliers produce smaller parts of more complicated shapes, using smaller equipment that is not automated as much, and therefore items that take more time and trouble. And, while the former two carry out production by means of a division of labor within their own companies, the latter two carry out production by means of a division of labor between or among companies of many different types. And because automobiles are assembled by all these parts being combined together, we saw that from the middle of the 1960s the rapid expansion in passenger vehicle production and the establishment and development of the Toyota production system (with just-in-time as the core) in response to that expansion all worked together to stimulate a wide variety of secondary suppliers to combine together in and around Toyota City to form an industrial cluster.