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THE DEVELOPMENT OF THE BICYCLE INDUSTRY IN JAPAN AFTER WORLD WAR II

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CONTENTS

INTRODUCTION

Japan's bicycle industry today accounts for only 0.2 per cent of the combined value of the products shipped out by all manufacturing industries in the country,[1] but the total worth of its exports — surpassing in and after 1967 that of the UK, once the world leader in bicycle production — is ranked first in the world,[2] while its output is second only to that of the US.[3]

Bicycles are believed to have first come to Japan in the early Meiji years, shortly after its self-imposed isolation had come to an end, and bicycle production in this country, beginning with the manufacture of spare parts for and the repair of imported bicycles, has developed through many vicissitudes in a process of adapting itself to the Japanese environment.

As the history of development before World War II will be described by Mr. Tsuneyoshi Takeuchi, my paper will review the postwar development of the Japanese bicycle industry following its almost fatal destruction by the war, analyse its present structure, trace its technological development in that connection, and look into its problems. The sources of information on which my report is based are listed at the end of each section for readers' reference.

I. DEVELOPMENT AFTER WORLD WAR II

1. Production Trends in Different Phases

In 1945, the year World War II ended, only 18,000 finished bicycles were produced in Japan, far below the prewar peak reached in 1940, when 1.25 million finished bicycles worth ¥89 million were produced, together with parts totalling ¥21 million in value. Thus bicycle production was resumed in postwar Japan virtually from scratch.

As indicated by the figures in Table 4, giving statistics for output, import, and export of bicycles in Japan, the postwar period can be divided into the following phases in terms of finished bicycle production trends.

1) Reconstruction phase, 1946-1950: Annual output grew from 100,000 to 1,000,000 units. (Goods were in short supply under controlled economy; anything produced would sell.)
2) Stagnation phase, 1951-1955: Annual output hovered between 1,000,000 and 1,100,000. (Domestic demand stagnated after the Korean War cease-fire.)
3) Growth phase, 1956-1960: Annual output soared from 1,400,000 to 3,000,000. (Domestic demand rose sharply as business activity picked up in Japan.)
4) Transition phase, 1961-1965: Annual output levelled off at between 3,100,000 and 3,200,000. (Utility bicycles were replaced by cars; the bulk of demand shifted to lighter models; exports to the US started.)
5) Great leap phase, 1966-1970: Annual output soared from 3,600,000 to 4,500,000. (Exports increased; sport models and other new types were developed.)

6) Boom phase, 1971-1973: Annual output jumped from 5,000,000 to 9,400,000. (Both domestic and export demand expanded; there was a boom in mini-cycles.)
7) Reactionary slump and overproduction phase, 1974-1978: Annual output fell off to 6,000,000. (Domestic demand stagnated; yen appreciation suppressed exports; competition emerged from developing nations.)

Thus there was a more or less regular trend whereby the annual output of finished bicycles alternated in approximately five-year phases between growth and stagnation from the end of World War II until 1970.[4]

From 1971 to 1973 there was a boom in bicycles, followed by a reactionary slump from 1974.

Meanwhile the output of bicycle parts showed a roughly similar trend to that of finished products. This is not surprising, since the output figure included the parts that were assembled into finished bicycles and a growth in finished bicycles sales necessarily resulted in an increase in the demand for parts. In the next section each phase will be analysed in some detail with reference to changes in demand structure.

2. Changes in Demand Structure

There are two aspects to the demand for bicycles, reflecting their use as a means of transport or pleasure.

In historical terms, the demand for bicycles in the early stage of industrialization increased mainly as a result of the practical need to carry goods and/or people. This trend is still found in many developing countries nowadays. As industrialization advances later on, bicycles as a practical means of transportation are increasingly replaced by automobiles, and demand for bicycles stagnates. However, with the advent of an affluent society where people's average income is above a certain level, bicycles come to find a new demand as a source of sport and amusement.[5]

Japan has experienced this common process since the end of World War II. Until the 1950s, bicycles were mostly used by common people as a means of personal transit or by small stores and factories for the transport of goods. As the Japanese economy passed its reconstruction stage and entered a phase of expansion, the bicycle as a utility item was gradually replaced by the automobile, and the bicycle industry entered the 1961-1965 phase of transition referred to above.

It was in 1957 that the Ministry of International Trade and Industry began to classify statistical data on bicycle production by vehicle type. As indicated by Table 5, in which annual bicycle output from that year on is classified by type, the proportion of utility vehicles in the total output of finished bicycles kept on shrinking after reaching a peak of 76 per cent in 1959, accompanied by a slowdown in the growth of the overall output of bicycles and by a quick increase in the production of automobiles. During the first half of the 1960s, it was even suspected that the bicycle industry was no longer adaptable to the rapidly growing Japanese economy.[6] Had utility types still constituted the mainstream of bicycle production, the overall output in this phase would have registered a much steeper decline. But since the demand for lighter bicycles and sport models started to increase in this five-year period, the overall output levelled off.[7] The production of utility bicycles continued to stagnate even in the industry's great leap phase from 1966 on, and their proportion of the total output of bicycles fell to less than 2 per cent by 1978.

In contrast, the proportion of lighter or sport models in the overall output of bicycles gradually rose from 12 per cent in 1958, surpassed that of utility types and constituted the biggest segment in 1964, and reached 57 per cent in 1967. Although their proportion shrank in 1968-1969 as a reaction to the preceding boom and as a result of the increase in children's and specialty items, lighter or sport models again held a 50 per cent share in 1970. In 1973, however, their share once again took a downturn, affected by the emergence of mini-cycles, which will be referred to below in greater detail.

The great leap in 1966-1970 after the transitional phase of 1961-1965 was mainly due to an increased demand for bicycles as a means of sport and physical exercise. In Japan, a campaign to promote cycling was actively staged by the association of bicycle manufacturers, whose efforts to develop improved lighter sport models began to bear fruit. Furthermore in the overseas market, including above all the US, demand for sport bicycles increased and improved Japanese products were able to satisfy this increased demand, resulting in a steady growth of exports from the second half of the 1960s.[8]

The boom in bicycles from 1971 on was attributable in part to the sympathetic acceptance of the "bicology" movement, which had originated in the US, by the increasingly environment-conscious Japanese public; to the active presentation of bicycle shows by the manufacturers' association among others; to improvements in the environment for cyclists including the construction of cycling roads; but mostly to the emergence of handy mini-cycles and their quick proliferation.

The vast sales mini-cycles achieved could be explained by their activation of a huge latent demand for a handy means of transit for the expanding suburban population (resulting from the "doughnut" pattern of the distribution of city dwellers), who needed something more than their own legs and feet to satisfy their shopping and other everyday requirements.[9]

Bicycle manufacturers made active capital investments to meet the rising demand for their products, but the boom proved only short-lived under the pressures of the general business recession following the oil crisis, and their output fell sharply from 1974 on. As a result, many of the production facilities newly installed during the boom were obliged to stay idle, pushing up the fixed costs to their owners and inviting a cutthroat sales race to reduce the burden of these increased fixed costs. Moreover the central role played by mini-cycles in bringing about a boom in demand adversely affected the trade-up strategy of bicycle manufacturers. The steady increase in the production of lighter and sports items during the second half of the 1960s had helped to put bicycles among the more luxuriously perceived and expensive products, but the emergence of mini-cycles,

though activating a latent demand, served to reduce the average unit sales price of bicycles and consequently their profitability for manufacturers.[10]

As regards bicycle parts, whose overall production, export, and import trends are summarized in Table 4, an itemized analysis is given in Table 6. As is evident in Table 7, in which the yearly shares of each item are given in percentages, those of the frame, mudguards, handlebars, rims, saddle, and gear case have decreased while those of the chain wheel and cranks, calliper brake, hubs, free wheel, and transmission have increased, reflecting the expanding output of technology-intensive parts to cope with the aforementioned trend for demand to shift from utility types to sport or pleasure vehicles.[11]

3. Changes in the International Environment

During 1936 and 1937, the prewar peak period of bicycle export from Japan, about half the output of the nation's bicycle industry was exported,[12] in part stimulated by the government's policy of encouraging export to the yen bloc, and bicycles held the leading share in the combined value of machinery exports from this country.[13]

Bicycle exports from Japan after World War II remained stagnant for many years until about 1960,[14] as Table 4 indicates.

In the 1960s, the export shipments of finished bicycles and their parts began to increase, taking a great leap from the second half of the decade until the 1970s. Finished-bicycle exports registered their postwar peak in 1972 at 1.55 million units or in 1974 at ¥22,900 million, 3.4 or 7.6 times, respectively, the corresponding level in 1965. The peak value of parts exports, achieved in 1974, was ¥49,200 million, representing a 10.5-fold increase over the 1965 record. An itemized breakdown of parts exports is given in Table 8; they show a generally parallel trend to the aforementioned item-by-item output.

During this process of export growth, a major change took place in the geographical destinations of bicycles exported from Japan. As the classification of bicycle shipments in value by region and country (Tables 9 and 10, respectively) indicates, the bulk of them went to Southeast Asia and a major part of the remainder was destined for Africa and Latin America in the 1950s. But from the 1960s on, export to North America, above all to the US, increased tremendously in contrast to a decline in the shares of those developing regions in the world market for Japanese-made bicycles.

The importance of the US market to the postwar export of Japanese bicycles increased so quickly that the proportion of US-bound shipments to the nation's overall bicycle exports soared from only 3 per cent in 1957 to 66 per cent by 1974.

Changes in the ratio between finished-bicycle and parts exports are traced in Table 11, broken down by region. The share of finished vehicles kept on increasing until about 1970, and then that of parts began to grow, indicating a shift of the dominant role in Japan's bicycle exports from finished products to parts over recent years.

While shipments to Europe from the outset almost wholly consisted of parts with a negligible proportion of finished vehicles, the latter's share in export to Southeast Asia and Latin America has shrunk, with a quick rise in the former's. Bicycle imports from Japan into semideveloped nations in East Asia consist almost wholly of parts and include quite an insignificant proportion of finished products. Nor do these nations import finished bicycles in substantial volumes from countries other than Japan. This means that bicycle makers in Taiwan and the ROK are now fully equipped to assemble finished bicycles out of components either imported from Japan or made domestically. More important, Taiwan in particular is emerging as a powerful competitor of Japan in the US market, as parts exports from Japan have played a major role in the assembly of finished bicycles in Taiwan.[15]

The US is the biggest bicycle producer[16] and importer[17] in the world. As there are no bicycle parts manufacturers in the US, unlike in Japan or Europe, American finished-bicycle makers have to depend for parts supply

wholly on imports from Japan, Europe, and, more recently, some developing countries. Parts production would not pay off in the US on account of the high labour cost among other factors. Stelber went bankrupt in 1977, and the bicycle industry in the US is now an oligopoly of six assembling manufacturers.[18]

The competitive situation between Japan and the semideveloped Asian nations in the US market for finished bicycles is represented by the figures in Table 13. In terms of value, while Japan's share in the market grew from 28 per cent in 1971 to 36 per cent by 1976, Taiwan's increased more significantly over the same period from only 3 to 23 per cent.

Taiwan's inroads into the US market were even more remarkable in number of units exported. Its share in the overall US import of finished bicycles, which was less than 5 per cent in 1971, expanded by 1976 to 34 per cent, consisting of 570,000 units and far surpassing Japan's 28 per cent share comprising 470,000 units.

This marked difference between value and volume trends seems attributable to the following factors:[19]

1) Taiwan's exports, as indicated in the table, mostly consist of lower-grade items, above all "high-risers" (which generally refers to children's bicycles in the US) of 24 inches or less in wheel diameter.
2) Japan's exports primarily comprise higher-grade items, above all adults' sport bicycles with 26-inch or larger wheels.
3) Japan has overwhelming strength in parts export to the US (Table 14).

Underlying Taiwan's concentration on the export of high-risers is the circumstance that this type is no longer a lucrative export item for Japanese manufacturers and is now produced by them exclusively for domestic consumption. Taiwan's products achieved success in the US market by taking advantage of this supply gap. American high-riser users have a unique preference for the coaster brake (which is applied by turning the chain in the reverse direction), and virtually all the bicycles intended for the US market are equipped with it. Though of lower grade, high-risers are the

standard type for children's use in the US and are believed to be in steady demand even during times when the economy is depressed. Primarily dependent on this type, Taiwan has expanded its bicycle exports to the US, and risen from its previous position as a marginal supplier to being a steady supply source. Today, Taiwan-made high-risers seem to enjoy an established competitive position in the US market.

In the market sector for higher-grade items, mainly comprising adults' sports bicycles with 26-inch or larger wheels, Japan is highly competitive with an over 40 per cent share in 1976, in both value and volume. Notably, however, Taiwan and the ROK are gradually building up their competitive strengths even in this sector, though their products of this grade include a substantial proportion of indirect exports from Japan because American importers usually specify that Japanese brands for such major technology-intensive components as transmissions and brakes be used in the finished bicycles they order from Taiwan or the ROK. Therefore, if the value of these Japanese-supplied parts is subtracted, the net worths of bicycle exports from the two countries will be somewhat smaller.

Meanwhile, the US market for bicycle parts is virtually monopolized by Japanese products, paralleled by none (Table 14), as a result of strenuous endeavours by Japanese manufacturers to improve their productive techniques and strengthen their price-competitiveness in the international market by concentrating on technology-intensive items, developing new products, and improving existing products. The non-price competitive strength of Japanese-made parts, for which brand penetration is a major factor, is firmly established. Since, as stated above, US-bound exports of Taiwanese and Korean finished bicycles are obliged to be fitted with Japanese products for their technology-intensive parts, there is no likelihood in the immediate future of any quick increase in parts exports from the semi-developed nations in East Asia to the US market.

The outlook further into the future, however, is a little different. In fact, the appreciation of the Japanese currency, which has tended to accelerate since late in 1977, constitutes a favourable factor to parts exports from Taiwan, which is said to have come into a range from where

it can reasonably expect to compete with Japan in saddles, tires, tubes, chains, rims, spokes, and so on.

Competitive situations in overseas markets other than the US will be briefly outlined below.[20]

In Canada, too, Taiwan is a formidable competitor. In 1973, a boom year for bicycles, Japan and Taiwan exported 280,000 and 150,000 units, respectively, but their relative positions were reversed by 1976, when 190,000 and 380,000 units, respectively, were shipped to Canada from the two countries.

Further, in Southeast Asia as well as the Near and Middle East, Taiwanese products established their dominance in the bicycle market from 1975 to 1976, seemingly putting an end to the Japan-Taiwan race in Third World markets as far as finished vehicles were concerned.

Since the need in developing nations is greater for low- and medium-grade bicycles than for high-grade ones, Taiwanese and Korean products are likely to continue to make massive inroads into these markets. In this context, the world bicycle industry seems to have come to a major turning point.

On the other hand, in the European market, where the bicycle industry is traditionally protected and fostered and where consumers' criteria of product preference are more stringent than in the US, Taiwanese and Korean bicycles are expected to find it more difficult to establish their presence. It therefore appears to be a more hopeful export market for Japanese-made bicycles and their parts.

As seen in Table 4, in which the trend of Japan's bicycle imports is also traced, finished-product inflows sharply increased from 1973 to 1974, totalling 140,000 units in the latter year, but they later decreased to a virtually negligible number, less than 10,000 a year in and after 1977. Parts imports, in contrast, steadily increased from 1972 on and reached ¥1,100 million in aggregate value in 1978. Their supply sources in 1978,

as listed in Table 15, included Singapore, Taiwan, and such advanced nations as Italy and France. Imports from Singapore and the ROK are likely to increase in the future because of their low price level.

II. CURRENT SITUATION AND STRUCTURAL FEATURES OF THE BICYCLE INDUSTRY

The foregoing review of the development of bicycle manufacturing in Japan after World War II has generally revealed, it is hoped, the historical background of the state of the industry today. The structural features of this industry are outlined below.

1. Localized Grouping of Smaller Enterprises

Out of the 1,175 establishments manufacturing bicycles and their parts in Japan, 783 or nearly 70 per cent are very small enterprises with 9 or fewer employees each, and only 9 establishments or less than 1 per cent are big businesses with 300 or more employees each, according to industrial statistics (Table 16).

The Japanese bicycle industry thus predominantly consists of medium- and small-scale enterprises, and these are clustered into localized groups in or around such big cities as Tokyo, Nagoya, and Osaka.

In a prefectural breakdown of annual shipments of bicycles and their parts (Table 17), the 4 prefectures of Saitama,[21] Tokyo, Aichi, and Osaka together account for 60 per cent of the national total of finished products. Although bicycles are also produced in 13 other prefectures, these prefectures are not identified in the statistics because each has only one or two manufacturing establishments.

In an analysis by bicycle type, major geographical sources of production are Saitama and Osaka for utility items, Tokyo and Aichi for children's items, and Tokyo for light, sport, and specialty models.

Manufacturers of bicycle parts are geographically more dispersed — in 34 prefectures of the country — than those of finished vehicles (Table 18). Here again, however, shipments are concentrated in a few areas, with the 4 prefectures of Osaka (59 per cent), Aichi (8 per cent), Tokyo (7 per cent), and Saitama (4 per cent) combined accounting for 78 per cent of the national total. The concentration is thus more conspicuous than in the production of finished bicycles.

In the ranking of prefectures according to the combined value of finished bicycles and parts shipped out, Osaka comes first with a share of 46 per cent, followed by Tokyo with 10 per cent, Aichi with 8 per cent, and Saitama with 8 per cent, in this order, the four areas together responsible for almost all bicycles and parts shipped out of factories in Japan. Osaka above all constitutes the nation's leading bicycle production centre and emphasizes the manufacture of parts.

Bicycle manufacturing in Osaka historically evolved from the traditional techniques of gunsmiths and swordsmiths in Sakai City, which were adapted to tempering and cutting procedures in the production of bicycle parts. Since the manufacture of spare parts for repairing imported bicycles was started there about the turn of the century, Osaka has always been the biggest centre of bicycle production in Japan. Looking deeper into the localized group of medium- and small-scale enterprises manufacturing bicycles and their parts, one finds a highly developed system of social division of labour, which will be described in the following section.

2. Independence of Parts Manufacturers

It has been pointed out that the Japanese bicycle industry is divided into the finished-vehicle sector and the parts sector. Each has its own specialized form of production.

Most characteristic of the Japanese bicycle industry is that parts manufacturers are independent of, rather than controlled by, finished-vehicle manufacturers.

Essentially, the manufacturing of bicycles, like that of automobiles or watches, is a typical assembly industry. It would normally take the form of a pyramid with the parent assembly factory at its top and subcontracting parts makers at its base, but in Japan parts manufacturing did not begin with a deliberate objective of contributing to the commercial production of finished bicycles.

The history of bicycle manufacturing in Japan began with the repair of imported bicycles and the production of replacement parts for them. This led to the emergence of parts manufacturers[22] and eventually developed into the manufacture of finished vehicles. Unlike in the automotive and chronometer industries, the technology of finished-product assembly could not play a decisive role in the development of bicycle manufacturing in Japan. For this reason, there was a delay in capital investments in the finished-bicycle assembly sector, resulting in a considerable lag in the start of large-scale systematic production.[23]

Especially in Osaka, the starting point was the production of replacement parts in cottage industries run by former gunsmiths and swordsmiths in Sakai. During the subsequent development, uniform standards were internationally prescribed for bicycle parts to establish interchangeability between the products of different manufacturers, and parts makers were thereby enabled to remain independent of, instead of becoming subordinate to, finished-bicycle manufacturers. Each component is thus expressly marked with the brand of its manufacturer.[24]

The standardization and interchangeability of parts further enables each of their manufacturers to supply many finished-bicycle makers with the same item. In other words, each component item is mass-produced by its manufacturers, and this productive structure prevents finished-vehicle manufacturers from undertaking integrated production, from individual components to finished bicycles, at competitive costs.[25]

Parts manufacturers are subject to a similar limitation. Even a major manufacturer produces on its own only a limited variety of specific parts;[26] moreover in many instances one finished component is the outcome of a relay

of different manufacturing procedures by a number of factories. The group making bicycle parts in Sakai, for example, consists of many medium- and small-size parts factories and related manufacturers densely clustered in a limited geographical area; these enterprises complement one another and are organized in an intricate network based on social division of labour and the parent enterprise-subcontractor relationship.[27]

A breakdown of bicycle manufacturing plants by product item (Table 19) shows that each item is now produced by only a few manufacturers, resulting in an oligopolistic structure for each finished component;[28] but each manufacturer, as is evident from Table 16, is surrounded by many suppliers ranging in scale from medium size to very small. The Japanese bicycle industry thus has a highly developed system of social division of labour, and at the same time its structure prevents newcomers from participating in it.

3. Mercantile Capital-like Character of the Assembling Sector

There are two types of finished-bicycle manufacturers.

The first is known as "industrial type" manufacturers. They are capable of producing frames and other specific parts on their own and of achieving assembly by a modern system including a conveyor line.

The second is "factor type" manufacturers. They have no facilities of their own to produce parts and merely assemble parts purchased from outside.

Industrial-type manufacturers attach importance to the production of frames because they can more readily differentiate their frames from competitors' products and because a frame is a vital part of a bicycle. Each manufacturer produces at most two or three kinds of parts other than frames, such as forks, handles, and mudguards, but parts production is now increasingly left to specialized manufacturers, and a growing number of industrial-type finished-bicycle manufacturers hardly produce any parts but frames.[29]

A factor-type finished-bicycle manufacturer buys all components from specialized makers and puts them together into finished bicycles. Some factor-type manufacturers assemble fully finished vehicles, while others ship out partly (50 per cent or 70 per cent, for instance) assembled sets.[30] Many of them also operate as wholesalers, distributing the products of finished-vehicle manufacturers or replacement parts.[31]

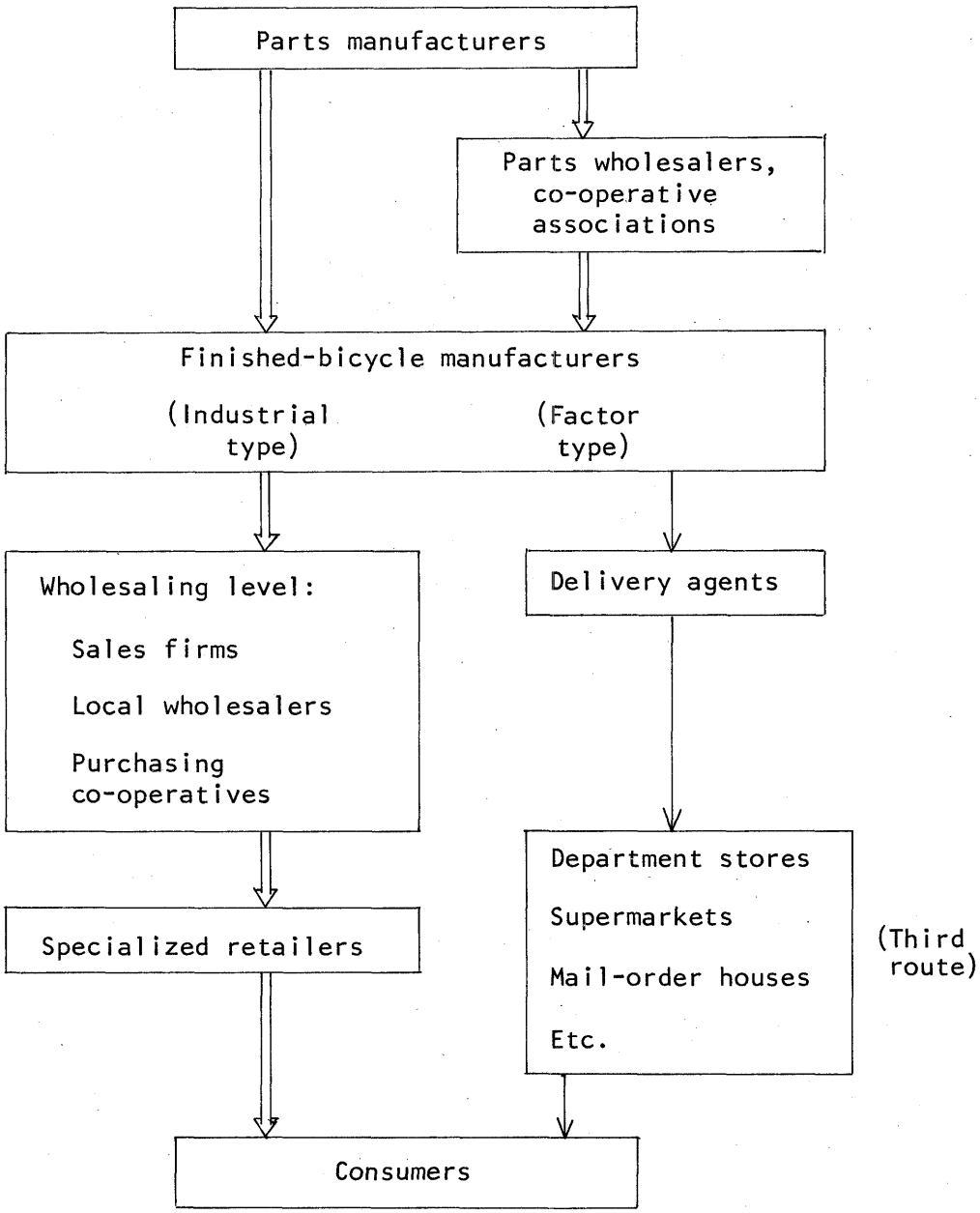
In the bicycle industry, the finished-vehicle assembly sector does not always need a technically massive production system. Manufacture of not only automobiles but even motorcycles requires a big factory because it involves production of engines and assembly of large, heavy parts. In contrast, assembly of bicycles is even simpler than the production of parts, so simple that it can be accomplished in a retail store. The raison d'être of major finished-bicycle manufacturers may be regarded as consisting primarily of their marketing function. The high quality of a reputable brand is achieved by procuring quality products from parts manufacturers and does not necessarily depend on the technical capability of the assembler.[32] In connection with the aforementioned independence of parts manufacturers, this mercantile capital-like character can be pointed out as a major feature of the finished-bicycle assembling sector.

4. Features of Marketing Structure

Marketing channels for bicycles are illustrated in the accompanying chart. Finished-bicycle manufacturers who assemble purchased parts, both of the "industrial" and of the "factor" type, have a wholesaling function. The most usual channel begins from parts manufacturers and goes by way of parts wholesalers to finished-vehicle manufacturers, local wholesalers, and finally to retailers. However, many small factor-type manufacturers are unable to buy individual components directly from their makers and instead repurchase them from major factor-type manufacturers.[33]

The difference between the marketing structure for bicycles and that of most other industries stems from the repair and final assembly functions of the retailers.[34] While the repair function is important to bicycles,

Flow Chart of Bicycle Marketing



which are durable consumer goods used for comparatively long periods, bicycle manufacturers, unlike manufacturers of electrical home appliances, have no servicing arrangements of their own; instead, retailers take charge of repairing. Although the qualitative improvement of bicycles over recent years has resulted in a decreasing trend of repair needs, still the sale of one bicycle is believed to create several occasions for repair a year, and these constitute an important income source for retailers.

Since specialized retailers have repair and assembly functions, department stores and supermarkets have been left behind in the selling of bicycles. However, since the improvement in quality of bicycles has served to reduce repair needs and the demand for bicycles has rapidly grown, typically in the mini-cycle boom, supermarkets and department stores have increasingly come to handle bicycles, and this has intensified frictions with traditional specialized retailers. Bicycles sold by supermarkets and the like are delivered to them by delivery agents in a fully assembled state.

For supermarkets, bicycles are a fairly lucrative item in terms of earning efficiency per unit floor space and can serve as a lure to shoppers, although the margin of profit on bicycles here is estimated at about half that of specialized retailers. This untraditional channel of marketing, which goes via supermarkets, department stores, mail-order houses (advertising in daily newspapers), and so on, is referred to in the industry as the third route.

Although some of the factor-type finished-bicycle manufacturers have rapidly grown by depending mainly on supermarkets and/or other third-route clients, finished-vehicle makers are generally hesitant to expand their third-route sales because these customers are irregular in purchase volume and moreover make stringent demands on price.

Since finished-bicycle manufacturers, even those of the industrial type, depend on parts makers for a predominant part of their supply of components, the proportion represented by purchased parts in their overall product cost is as great as 50 to 60 per cent, while their direct labour cost is only 8

or 9 per cent. Their margin of profit varies widely from one bicycle type to another and is further greatly affected by the trend of demand, so that the market prices of bicycles are liable to decline in times of business recession.

Whereas parts manufacturers, too, sometimes offer their products at reduced prices to maintain their output levels in a depressed period, the rate of reduction differs from one manufacturer to another. Those offering more generous discounts are more likely to run into financial difficulties.

Purchased components usually account for 60 to 70 per cent of the cost of a bicycle produced by a factor-type finished-vehicle manufacturer, while the proportion of the direct labour cost is only about 6 per cent. Very small factor-type manufacturers rarely retain full-time assembly workers and usually have their products assembled on a piecework commission basis. For this reason, the proportion of their fixed costs is extremely small and therefore enables cottage manufacturers to survive recessions.[35]

III. TECHNOLOGICAL DEVELOPMENT AND STRUCTURAL CHANGES IN PRODUCTION AND MARKETING

1. Technological Stagnation Due to War

Bicycle production facilities were virtually non-existent in Japan during the final phase of World War II because they had been considerably damaged by air raids and because those that survived the bombing had been switched to production of war supplies.

> To describe plainly what the Japanese economy was like in the summer of 1945, there were vast ruins of munitions production facilities which were no longer of any value, and on the other hand too many people were scrambling for what little consumer goods were left to them. To look at the surviving production capacities of consumer-related industries, in terms of proportion to the maximum prewar level, the textile sector had only 33 per cent, the ammonium sulphate sector 42 per cent, the paper sector 46 per cent, and the bicycle sector 20 per cent. Moreover, most of their remaining facilities were standing idle on account of their own obsoleteness, scarcity of raw materials, and destruction of marketing mechanisms.[36]

It was nevertheless relatively easy to return munitions factories, which had gone out of use after the end of the war, to their original role of bicycle production, and this was one of the factors which facilitated reconstruction of the industry. The national total of bicycles owned, which had reached nearly 10 million units before the war, was only 5 million immediately after the war (Table 20), and many of them were in so miserable a state that ropes were wound around their rims in place of tyres. Accordingly there was an almost limitless demand for bicycles.[37]

Bicycle manufacturers who had survived the war had facilities, even though obsolete, which were usable for production of bicycles and parts, but raw materials were rationed and factory outputs were thereby limited. In the

meantime, however, there evolved black market prices for ration coupons as well as black market supplies of materials, enabling manufacturers to produce more than their rations allowed. By that time, all kinds of material necessities of life had become available at (black) market prices, and bicycles were among the items most in demand.[38]

People would hardly question the price or quality, and all new bicycles put on sale sold like hotcakes. It was not rare for a person who bought a bicycle in the morning to get a flat tyre or to find its handle making strange noises before the end of the same day. Tyres and tubes especially, both made of rubber whose supply depended solely on imports, were treated like valuables. Although tyres and tubes were supposed to be rationed together with other parts, the supply of tyres and tubes versus that of bodies was so enormously unbalanced in reality that "bicycles without tyres or tubes" were marketed on both legitimate and shady channels.[39]

The authorized producer price for a bicycle, proclaimed by the Ministry of Finance and Price Agency, was successively raised from ¥310 in August 1945 to ¥895 in 1946, ¥3,200 late in 1947, and ¥6,300 in July 1948, but as it was thereafter uniformly fixed at ¥6,300 without distinguishing first-class products from inferior ones, conscientious manufacturers of established brands since prewar days suffered doubly. However, as inflation subsided in 1949, the bottom price became the official price, and prestige brands came to be sold with premiums. Then, from about the spring of 1950 on, only first-class products could be marketed at the official price, and second- or lower-class ones were priced below that level, from ¥4,800 to ¥6,000. Eventually, in March 1950, the price control was lifted and thereafter the producer price came to vary widely from ¥5,000 to ¥10,000, with a correspondingly wide range of retail price from ¥6,000 to ¥12,000 (the highest-class product complete with accessories was priced at nearly ¥20,000). Entering a period of free competition, the bicycle industry was about to undergo realignment.[40]

One of the notable trends during the early postwar period of governmental control was an increase in bicycles assembled by "factors" or wholesalers (sometimes retailers), and factor-type manufacturers accordingly recovered

a significant part of their prewar influence. What was directly responsible for this trend was that, although there were rigid official controls on the price and rationed quantities of finished vehicles, parts were subject only to price control and there were no restrictions on buying components and assembling them into finished bicycles. This gave factors the room they needed to achieve substantial growth.[41]

On the other hand, some manufacturers who had previously specialized in production of parts began to assemble bicycles because finished-vehicle manufacturers were more favoured in the rationing of materials, but most of these manufacturers returned to their traditional trade of parts production as free competition was resumed.[42]

2. Participation of Former Major Munitions Plants

One of the major postwar developments was the participation and temporary holding of important positions in the bicycle industry by former munitions factories, which had had no part in this sector before World War II.

These munitions plants were deprived of their facilities directly intended for production of war supplies, but they still had precision machine tools and skilled technicians to operate them, although both now had to stand idle day after day. These factories moreover still held in stock considerable quantities of materials including Duralumin and steel.[43]

The former munitions makers which after the war suddenly switched to the peace industry of bicycle manufacturing were referred to in this sector as "converted makers." They included such major enterprises as the Tsu machinery works of Mitsubishi Heavy Industries, the Gifu works of Kayaba Industry, Nihon Kinzoku Sangyō, Nakanishi Kinzoku, Handa Kinzoku, Fujikoshi Kōzai, the Ōta works of Fuji Sangyō, Takasago Tekkō, Amatsuji Kōgyō, Katakura Kōgyō, Nishinihon Kōgyō, Nakayama Taiyōdō, Daidō Seikō, and Daiwa Bōseki.[44]

The participation of these converted makers in the bicycle industry, which in prewar days had had no more than a half-dozen major manufacturers of finished vehicles, including Miyata Seisakusho, Dainihon Jitensha, and Okamoto Jitensha,[45] exerted considerable pressure on the traditional manufacturers for a certain period of time.

> Strictly speaking, it was not until around the postwar year of 1949 that Japanese manufacturers of finished bicycles departed from their traditional factorlike way of producing to order, instead set their own standards, each putting its own unified mark on its products, and began to produce in competition with one another.[46]

The participation of converted makers undeniably stimulated this development, especially in the technological aspect.[47]

The fact that the bicycle plants in 1947 were generally of a greater scale than those in the prewar peak year of 1937 (in 1947 there were 69 plants with 100 or more employees each, in contrast to 22 in 1937; see Table 21) is considered attributable only to the participation of converted makers.[48]

> In the allocation of finished-bicycle production quotas by the Ministry of International Trade and Industry for the first and second quarters of fiscal 1949, the so-called converted makers were allowed to produce 106,000 vehicles, accounting for 38 per cent of the total output. The inroads made by the converted makers caused some observers to expect a growth in the scale of bicycle production, but the subsequent development was contrary to this expectation.[49]

The converted makers, who shook the postwar bicycle industry, successively retreated from this sector with only one exception.[50]

As the system of controlled economy was replaced by that of free competition, resulting in the revival of "factors," factor-type manufacturers of finished bicycles applied pressures on converted makers, who had entered the bicycle market with great industrial capital. The latter were faced with problems arising from their difficulties in transactions with parts manufacturers and the weakness of their marketing machineries, and found themselves unadaptable to the peculiarities and structure of the bicycle industry that were the outcomes of its unique process of development.

Moreover, the outbreak of the Korean War in June 1950 and the ensuing boom of special procurements by the US Armed Forces gave the converted makers a good opportunity for reconversion.

3. Promotional Subsidy and Technological Development

The technological progress of the Japanese bicycle industry after World War II cannot be duly assessed without referring to the subsidy for promotion of the bicycle industry derived from the profits of bicycle races and the promotional activities financed therewith.

The Bicycle Racing Law promulgated in August 1948 defined the purpose of the subsidy: "to contribute to improving and increasing the production and export of bicycles, and satisfying the domestic demand therefor, and at the same time to increase the revenues of local governments."[51] Thus a legal basis was laid for channelling state funds, out of earnings from bicycle races, into the bicycle industry. For this sector, which, unlike many key industries, had never enjoyed state protection, the institution of the promotional subsidy was a major event that cannot be overlooked in tracing the reconstruction and development of the industry after World War II.[52]

The purposes of the subsidy were classified into four main categories, which covered the activities detailed below.[53]

1) Improvement of bicycle production techniques and product quality: (a) import and performance study of foreign bicycles, (b) compilation and distribution of both domestic and overseas patent information concerning bicycles, (c) testing of bicycle equipment and product performance, (d) financial assistance to bicycle-production facilities, (e) financial assistance to research in bicycle-related industries, (f) financing of research on machinery, (g) financial assistance to tests for implementation of inventions concerning bicycles, (h) establishment of a bicycle testing system, (i) standardization of bicycle manufacturing, (j) financing of export inspection, and (k) financing of

bicycle performance tests.

2) Promotion of bicycle export: (a) overseas dispatching of field-survey personnel, (b) surveying of first-hand information from overseas, (c) distribution of sample bicycles for overseas publicity, (d) production and distribution of catalogues in English for overseas publicity, (e) circuit displaying of bicycles, etc., in overseas markets, (f) production and distribution of films for overseas publicity, (g) financial assistance to international exhibitions of machinery for export, and (h) financial assistance to participation in overseas trade fairs.
3) Guidance of rationalization efforts by smaller bicycle manufacturers: (a) surveying of the current state of the bicycle industry, (b) a campaign for standardization of bicycle retailing practices, (c) financial assistance to facilities for joint use by smaller bicycle manufacturers, and (d) financial assistance to guidance of efficiency diagnoses of smaller bicycle manufacturers.
4) Loans to the bicycle industry. These were extended to manufacturers by the Smaller Business Finance Corporation through the Bank for Commercial and Industrial Cooperatives and 11 city banks.

As shown in Table 22, a total of ¥38,800 million was provided as promotional subsidy to the bicycle industry during the three decades from 1949 through 1978, and out of this total 48 and 26 per cent, respectively, were spent for improving production techniques and rationalizing bicycle manufacturing. The contribution of the subsidy to the technical progress of the bicycle industry will be briefly described below.

During the five years from 1949 (when the promotional subsidy was instituted) through 1953, about ¥2,000 million, a tremendously generous sum at that time, was directly drawn out of the national treasury to subsidize the bicycle industry. Mainly used for loans both to the industry as a whole and to individual manufacturers, these funds are considered to have played a major role in filling the technological gap which had resulted from wartime stagnation.

The blueprint for steps to promote the bicycle industry, which could by no means be taken by individual manufacturers — including making up for wartime delays in production techniques and loss of overseas

markets, raising the output level of domestic production, and surveying the actual marketing structure and modernizing it — was mapped out in this period, and the effects of these steps permeated the industry like water irrigating drought-stricken farm land. Many products and techniques which are now commonplace, such as the step spoke, light alloy rim, padded tube, tapered tube and high-frequency rubber vulcanization, were studied and developed for practical use under the subsidized promotional projects in those days. The local production and marketing, from about 1951 on, of road racers, unprecedented in Japan though already commercially available in Europe, were made possible by the development of techniques to manufacture their parts. The "research on techniques to produce electro-unite steel tubes for bicycles" commissioned to Toshiba Kōkan in 1950 contributed to the subsequent widespread use of electro-unite tubes in Japan.[54]

In September 1954 the Open Research Centre for Bicycle Production Techniques was established in borrowed space in the Nagoya Industrial Science and Technology Laboratories of the Agency of Industrial Science and Technology as a common facility of the industry for improving its bicycle production techniques. Financed with the promotional subsidy, two test plants were built, equipped with necessary machinery and instruments, and staffed by qualified research personnel. The centre undertook studies on all aspects of production techniques related to bicycle manufacturing, including materials, plasticizing, joining, painting, and plating, and their results were made public. Branches of the centre were established in Tokyo and Osaka to give guidance to manufacturers.[55]

The Open Research Centre in October 1958 was reorganized into an independent body by the name of the Bicycle Technology Research Foundation. With its integrated research laboratories in Nagoya and guidance service stations in Tokyo and Osaka, the foundation was supposed to function as a technical centre to engage in research projects for qualitative improvement and cost reduction of bicycles and further to make widely known, and extend guidance in the utilization of, the fruits of these projects.[56]

In June 1968 this Bicycle Technology Research Foundation moved to a newly acquired 40,020 m^2 site in Inuyama City, Aichi Prefecture. In September 1971 the guidance service stations in Tokyo and Osaka became branches[57] under the unified control of the foundation, and have since remained in this status.

The role played today by the foundation together with its Osaka Branch is evaluated below by the Osaka Prefectural Government in its Jiba Sangyō Gijutsu Jittai Chōsa Hōkokusho:

> Blessed with a relatively ample supply of funds, they have fairly sophisticated equipment and instruments. Besides seeking technical advice and commissioning tests or processing, individual enterprises participate in technical discussion meetings (on bicycles, dies, and environment) with a view to acquiring information on new techniques and selecting themes for joint development projects. Development of specialized machines, which can lead to the evolution of new production techniques, is undertaken by machine-tool manufacturers as well as by principal bicycle makers, and thus technology transfers sometimes take place through the introduction of new equipment or machinery. Even in such cases, however, experimental activities at the Bicycle Technology Research Foundation seem to play an important role.[58]

4. Institution of JIS and Transformation of the Finished-Bicycle Assembling Sector

Since bicycle production in Japan began with local manufacturing of British bicycles and their parts, then holding the biggest share in the world market, it extensively conformed to the British Standards (BS) from its earliest days. Even today, in spite of the general use of the metric system, the Japanese Industrial Standards (JIS) on bolts, steel balls, and dimensions of fitted parts all follow their British counterparts in "inch sizes translated into metric expressions."[59]

In 1949, the JIS system came into being as the Industrial Standardization Law took effect, but it was not until 1953, as indicated in the following chronology,[60] that the JIS marking system (under which, on the basis of Article 19 of said law, manufacturers are authorized by the state to put JIS marks on the products of their factories) began to be applied to bicycle factories.

Months and Years in which the Bicycle or Its Parts Became JIS-Designated Items

December 1953:	Rims, spokes, chain
February 1955:	Chain wheel and cranks, pedals, free wheel, hub sprocket
May 1956:	Rim brakes, hub brake, handle, hubs, coaster hub
May 1957:	Frame, front forks
July 1958:	Mudguards, saddle
June 1960:	Bicycle (finished product)
1960:	The number of factories producing 16 principal component items and authorized to put on JIS marks reaches 235 (out of 379 factories turning out such items).
1961:	In connection with the JIS designation of finished bicycles, retailers' skills begin to be tested and bicycles bearing the JIS mark begin to be screened.
1962:	Shipments of fully assembled bicycles begin. Application of JIS to finished bicycles enters the implementation stage.

As briefly reviewed above, the JIS designation of the bicycle and its parts began in 1953, first covering such capital-intensive items as the rim, spoke, and chain, which had already been produced by highly mechanized and automated processes. Then from 1955 to 1956 it extended to such technology-intensive items as the chain wheel and cranks and free wheel, whose production processes mainly consist of machining and assembling. It further proceeded in 1957 to such skill-intensive items as the frame and front fork, which are primarily produced by metal processing and joining. Finally in 1960 it arrived at the finished bicycle.

The delay in the JIS designation for a finished bicycle produced by assembling a large number of components was due to a difficult problem peculiar to bicycle manufacturing.[61] By about this time, finished-bicycle manufacturers in many cases refrained from fully assembling their products in their own factories; instead, they packaged sets of all the required parts and accessories and distributed them through local wholesalers to retailers, who assembled the sets into finished bicycles in their shops. Had the manufac-

turers fully assembled bicycles, they would have needed large work forces and factory space because of their inadequate equipment. Fully assembled shipments would have been greater in cubic measure, cost more to transport, and been more cumbersome to handle; retailers would have lost assembling commissions, which constituted a large part of their earnings.[62]

If we regard assembly of finished bicycles as a step in the manufacturing process, the retail store in which the assembly is done can be deemed a part of the factory. Accordingly, for the finished bicycle to be authorized to carry the JIS mark, the retailer assembling it had to be officially recognized as a technician capable of assembling a bicycle bearing the JIS mark, and for this reason it was decided to screen and qualify technicians to assemble finished, JIS-designated bicycles.[63]

After extensive preparations, including technical qualification tests and technical training sessions held by the Japan Bicycle Testing Society for over 60,000 bicycle retailers in the country, the finished bicycle became a JIS-designated item in June 1960, and it was in May 1962 that JIS-designated finished-bicycle factories came into being.[64]

Meanwhile, since JIS requirements on finished bicycles had in any case been set forth and US-bound exports of fully assembled vehicles began to increase in 1960 or 1961, major manufacturers decided on a new policy of shipping finished bicycles that had been fully assembled in their own factories. From 1962 on, most manufacturers of finished vehicles shipped fully assembled products on a regular basis.[65] Major manufacturers of finished bicycles quickly strengthened their assembly function by introducing belt conveyors, French-made wheel-assembling machines, and the assembly-line system with a view to expanding their mass-production capabilities and marketing networks. For instance, Bridgestone Cycle and Yamaguchi Jitensha tried to achieve monthly sales of 30,000 and 50,000 units, respectively, the former by introducing a die-cast process and the latter by expanding its sales network. Modifying their marketing policies, they further endeavoured to develop new markets by separating their sales departments as independent companies, actively strengthening their sales agents, and extending marketing guidance to retail stores.[66]

Not to be overlooked in this connection are the ties between major manufacturers of finished bicycles and integrated trading companies or big industrial interests, which became more conspicuous in this period. To expand their markets, Miyata Seisakusho joined hands with Mitsui & Co., Dainihon Jitensha with C. Itoh & Co., Nichibei Fuji Jitensha with Tokyo Shokuhin, and Welby with Marubeni-Iida, all for co-operation in sales activities, and a capital link was formed between Miyata and Matsushita Electric Industrial Co. to strengthen the former's mass-production capabilities.[67]

Another notable factor was the development of techniques for packaging-assembly. By the time US-bound exports of finished bicycles began to increase in or around 1960, American importers had established the practice of accepting only separate corrugated fibreboard packages of one bicycle each, but not those of half-dozens or dozens together. Japanese exporters therefore hastened to develop, and put into practice, techniques for single-bicycle packaging-assembly, and this also greatly contributed to rapid and radical changes in the domestic situation.[68]

Retail stores, which had previously served as final assembly and repair shops, found it more lucrative to develop new needs than to count on assembling commissions, partly because of the aggravating shortage of manpower. Those in urban areas especially began to reorganize themselves from repair shops into modern sales stores.

This trend induced finished-bicycle manufacturers to further step up the scale of their production and accelerated the tendency of bicycle manufacturing toward concentration. Reflecting this tendency, the number of such manufacturers shrank from over 190 in 1958 to below 100 by 1969, as indicated in Table 19.

Notably, in the course of the development reviewed above, the position of factor-type manufacturers gradually weakened. As stated previously, factors revived after World War II, and in 1955 shipments by factor-type manufacturers of finished bicycles accounted for 70 per cent of the overall national total, while those by industrial-type manufacturers represented 30 per cent.[69]

The relative positions of the two types became about even by 1962 and were reversed by 1969, when the former's share was 30 per cent and the latter's was 70 per cent.[70] Along with the aforementioned increase in the proportion of shipments of assembled bicycles by finished-vehicle manufacturers instead of sets of unassembled parts, factor-type manufacturers, most of whom were smaller-scale enterprises, found it difficult to introduce the conveyor system; unlike industrial-type manufacturers, who increasingly used conveyor-based assembly lines, they became almost unable to ship out assembled products, partly on account of the intensified shortage of manpower.[71]

5. Technological Development and Stratification of the Bicycle-Parts Industry

As already stated, the technological progress of the Japanese bicycle industry was prevented during World War II, and in the postwar reconstruction period of 1945-1950 when economic activities were still under state control any bicycle that was produced could be immediately sold in spite of its low quality resulting from obsolete production equipment and techniques.

In its first postwar white paper on industrial technology, entitled "The Situation of Industrial Technology in Japan" and published in November 1949, the Industrial Technology Agency of the Ministry of International Trade and Industry discussed the technological lag of the Japanese bicycle industry, above all its parts-manufacturing sector, as quoted below.

> Japanese bicycles in the past were nothing more than superficial copies of foreign products. Although this circumstance contributed to the prosperous export of bicycles in the form of unassembled parts, which are exchangeable with the corresponding ones of British-made bicycles because Japanese standards on bicycle parts were set dimensionally identical with the British, at the same time it not only invited inadequate strength and hardness but also suppressed Japanese manufacturers' intitiave in qualitative and structural improvements. These adverse effects are clearly seen when Japanese and British bicycles are compared.

> Structurally viewed, Japanese products lack transmissions and dynamo hubs, which have recently become particularly common on British vehicles. Japanese bicycles have virtually no variety.
>
> The Japanese industry lags behind in manufacturing techniques as well. For example, plating, which accounts for 23 per cent of the total manhours spent in bicycle production, heavily depends on manual work because automatic buffing machines are rarely used, and the conveyor-based automatic plating system capable of accomplishing the whole plating process from degreasing and water-washing to plating as such and drying is not so widely used either. In the machining stage, which takes up 35 per cent of the total manhours, automatic machines including automatic feeding presses and automatic thread-cutting machines are still uncommon. While this backwardness in part derives from economic disadvantages and other understandable circumstances, in view of the fact that foreign competitors, above all the British, are achieving remarkable development encouraged by postwar export drives and are steadily building up their superior positions both in product quality and price, Japanese manufacturers are called on to modernize their equipment.[72]

As this white paper also suggested, the immediate goal for Japanese bicycle manufacturers, both before and after the war, was to catch up with their British counterparts.

> In 1949, 33 units of the most up-to-date models of British-made bicycles were purchased. The imported British bicycles were sport and light models. Their frames were built of special steel pipes to reduce their weights. The bicycles had calliper brakes, epicyclic gear or hub gear-derailer variable transmissions, and/or WO rim tyres. From the processing point of view, such sophisticated techniques were used as press punching for gear teeth and cold forging for the bracket axle. The surface was finished by bright electroplating or with metallic paint, and the finish on invisible parts was dispensed with. All these features seemed to embody thorough rationalization efforts.
>
> Both the calliper brakes and variable transmissions had been theoretically known since before the war and even produced on a trial basis in Japan, but, looking at bicycles actually equipped with these devices, Japanese engineers renewed their awareness of the long blank from before to after World War II.
>
> Japanese bicycle manufacturers joined hands and accelerated their research and developmental endeavours. They imported and carefully analysed the most up-to-date bicycles from Switzerland, France, and Italy. To make Japanese bicycles marketable in the world, they had to catch up with the Europeans, who were far ahead of them, and eventually outstrip them.[73]

In the Japanese bicycle industry, every component manufacturer specializes in one or a few items. As the postwar curbs on economic activities were

lifted and the free enterprise system revived, parts manufacturers, each independent of others, competitively undertook technological development and equipment rationalization with a view to filling the aforementioned wide technological gap which then existed between them and advanced bicycle manufacturers abroad. From 1960 on, since the intensified shortage of manpower resulted in an increased need for cost reduction through productivity enhancement and the institution of JIS on bicycle parts[74] served to accelerate unification of standards, it became easier for each JIS-authorized factory to produce a limited variety of items in large quantities; rationalization of equipment was thereby given added impetus.

In 1960, US-bound exports of Japanese bicycles began to increase, and in 1967 the overall value of bicycles exported from Japan surpassed that from the UK (Table 2). It was in this period that the mainstream of Japanese-made bicycles shifted from utility items to higher-grade models - light and sport bicycles - requiring more sophisticated technology, and in the course of this shift the technological level of Japanese bicycle-parts manufacturers did overtake and outstrip that of the previously more advanced manufacturers in other countries. Because of the vast variety of bicycle parts and the difference in technological development orientation from one sector to another, it is difficult to draw an overall picture of the technological progress which took place in the industry, but an attempt will be made below to outline it mainly on the basis of a survey made on bicycle manufacturers in Osaka in this period[75] - a review of a ten-year period back from 1968 - with supplementary reference to the finding of recent hearings (in Sakai City, Osaka) and other data.

a. Continuous Automatic Painting System

Every stage of the painting process had been manually accomplished, but in or around 1955 automatic painting systems began to be used. They were electrostatic spray painting machines, which not only consumed less paint and afforded better finish than previously used tools but also helped treble the productive efficiency.

b. Continuous Automatic-Plating System

Only a handful of better-off bicycle manufacturers can afford to have plating equipment of their own, and minor manufacturers usually job out plating needs to specialized firms. Since the 1960s, major manufacturers of bicycle parts have equipped themselves with continuous automatic-plating machines, which have the following advantages over previously used semi-automatic devices: (1) As they require no heavy labour, they can be handled by female workers alone, (2) the productive efficiency is trebled without expanding the work force, and (3) the product quality is improved.

c. Cold Forging

Among bicycle components, not a few items require forging, such as shafts, the adjusting cup, flanged cut, and free wheel. Forging had previously been achieved by a hot process, but in 1960 a major parts manufacturer[76] developed its own cold-forging technique and in 1964 introduced automated cold-forging knowhow and a system under a technical licence arrangement with Brown Engineering Company of the US to further advance rationalization of its production process. This triggered extensive use of cold forging, which was an epochal new technique,[77] greatly contributing to improvement of product quality, saving of materials, reduction of production steps required, and amelioration of the working environment.

d. Automatic Processing Machines

During the 1960s, individual manufacturers made active automation attempts, each on its own. Many companies tried to develop machines for their exclusive use and, out of 89 surveyed, 54 companies or 61 per cent had succeeded in working out automatic machines of their own design. Virtually all manufacturers with 30 or more employees developed automatic machines for almost all kinds of bicycle parts. What had previously needed two workers could now be handled by only one, and what had depended on male labour could be accomplished by female hands, to cite but a few examples of the resultant labour saving.

e. Besides these improvements in the production process, the swaging machine (to taper the ends of round steel rods) was introduced for shaping the front forks, which previously had had to be pressed. Quenching for greater sturdiness and durability began to be used, and this also contributed to improved product quality. Hydraulic power came to be extensively employed to replace manual force. In the free-wheel fabricating process, hobbing machines were replaced by large presses, bringing about an estimated tenfold increase in processing efficiency.

Underlying these technological developments and equipment rationalization in bicycle-parts manufacturing were the contributions of the aforementioned subsidy for promotion of the bicycle industry. It is also worthy of note that government support was extended to other aspects as well in the framework of the Law for Promotion of Modernization of Smaller Enterprises, under which the bicycle-parts industry, except its rim and chain sectors, was singled out for a privileged position.[78]

Thus, throughout the phase of transition from utility vehicles to light and sport models, technological development and rationalization of equipment made progress in bicycle-parts production, and this process was accompanied by a structural change in the bicycle industry.

It has already been pointed out that finished-bicycle manufacturers grew in scale of business and their number decreased as a result of the concentration of production into the hands of fewer makers (see the preceding section). In the parts industry, too, the number of manufacturers decreased in every sector as indicated in Table 19, and production concentrated into larger companies.

Looking at the trend of bicycle and parts manufacturers classified by the number of employees (Table 23), the total number of factories continually decreased as years went by, from 1960 to 1965 and further to 1970. This reflects the withdrawal of many manufacturers who failed to adapt themselves to the changes which took place as well as the resultant restructuring of the industry.

While small manufacturers with 29 or fewer employees each registered a decrease in absolute number and a slight increase in relative share over the 1960-1970-1975 period, middle-class manufacturers with 30 to 99 employees each decreased in both absolute and relative terms, and no significant change was observed in the upper brackets with 100 or more employees each.

Over the same period, the number of employees decreased on an industry-wide basis, and the decrease was particularly conspicuous in the middle class while there was an increase in the upper strata.

Concentration into bigger manufacturers was more evident in the value of products shipped. To sum up, it is clearly seen that the bicycle industry was restratified into upper and lower layers at the cost of the middle class.

There was also a change in the relationship between the manufacturers of finished parts and those producing subparts on a subcontract basis. Major parts makers followed the policy of concentrating their own productive forces on those items they had developed that involved sophisticated know-how and jobbing out labour-intensive items requiring more manpower.[79] Underlying the firmly established presence of small manufacturers referred to above, there seems to have been this change in the pattern of social division of labour within the parts industry.

6. Themes of Technological Development

We have seen that the Japanese bicycle industry, in its process of departure from concentration on utility vehicles and diversification into the areas of light and sport models, and further into children's and ladies' items and mini-cycles, from 1960 on achieved remarkable progress in technological development and equipment rationalization, and this progress provided the technological basis for its subsequent great leap from the second half of the 1960s to the 1970s.

From 1977 to 1978, a survey was made on the technological situation of bicycle-parts manufacturers in Osaka Prefecture, and the author had an opportunity to participate in the discussion of the findings of the survey. Mainly on the basis of the report on this survey, [80] the circumstances and themes of technological development in the bicycle industry during recent years will be analysed in the rest of this paper.

It is necessary to look at some notable developments in a number of more important sectors of parts production before attempting an overall evaluation.

1) Frame: The frame is made by cutting pipe material, partially machining the cut segments, assembling them by welding and other means, painting, and finishing the assembled product. In this sector, which has been divided into small manufacturers engaged in assembling of subparts and big manufacturers specialized in fairly large-scale painting and finishing processes that have been nearly all automated since the early years, technological development has been achieved primarily in the following areas.

a. There has been a diversification of pipe materials from cast iron alone to high-tension steel, special steel, and light alloys. To meet the need for reduced weight, frequently used are chromium-molybdenum steel pipes ranging in thickness from 0.8 to 1.0 mm, which cannot be treated or machined by the skills of traditional craftsmanship.
b. In the machining and assembling process, too, remarkable progress has been achieved by the introduction of cold squeezing and various welding techniques to replace traditional filing and brazing (both requiring considerable skill).
c. In finishing as well as in painting, both methods and production technology have been improved, resulting in more advanced levels of continuity and automation.

2) Handlebars: Pipes are cut, machined, plated, and then assembled into handlebars. The individual steps, which were previously accomplished almost as a handicraft, have been transformed as described below.

a. Special cutting and machining devices have been developed to reduce the dependence on craftsmanship.

b. The plating process, which, including polishing, is of considerable importance, was previously carried out in a rather primitive way, but is now developing in the direction of automated continuous processing.

3) Chain wheel and cranks, hubs, free wheel, etc.: Various materials have to be pressed, machined, and/or forged to make these items, which moreover require particular precision and strength since they are rotating parts. As they involve much machining and complex assembling, they were previously considered difficult to mass-produce. The introduction of the cold-processing technique brought about the greatest change in this subsector. Thus, the complex process consisting of forging, pressing, machining, and heat treatment has been replaced by a much shorter one of heat treatment, surface finishing, and cold forging (press work), which moreover can produce all these components at the same time. This change gave rise to a new procedure of metal mould preparation for pressing, in which electro-discharge machining emerged as an important technique in addition to the conventional machining.

4) Brakes, pedals, etc.: This subsector used to mainly comprise assembly of many different subparts (about 90 kinds for a brake alone), supplemented by manual machining of a few main sub-items.

a. Here again, mass production was achieved by cold processing of main sub-units and by labour saving through the introduction of automatic machine tools.
b. Division of labour and flow process have begun to be introduced into the assembly stage, which has long been accomplished by unskilled workers (including women) in a cottage-industry fashion.

5) Rims, spokes, etc.: Since these components are relatively simple in shape, although they require strength and some precision techniques, their fabrication process was readily mechanized. Accordingly, their manufacturers are keenly interested in automation through development of specialized machines and also are greater in scale of business.

We have seen that, according to the characteristic features of individual component items, emphasis is placed on different technical problems and

that this difference leads to technological gaps and differentiation between stronger and weaker manufacturers.

It seems necessary, as a premise to considering technical problems of the whole bicycle industry, to identify common aspects of the production of diverse components together with the individuality of each subsector.

1) First, there are such cross-sectional themes as automatic production of parts, cold processing, rationalization of the assembly procedures, and automation of finishing procedures including painting and plating, all of which are related to labour saving, together with development of new materials, improvement of accuracy, and development of related machine tools. These are matters of hard technology development and are expected to facilitate directly the improvement of product quality, mass production, and cost reduction.

2) There also are problems of soft technology development including design improvement, choice of new vehicle types for new areas of demand, execution of quality control, and control of production and inspection procedures to meet the requirements of both domestic (JIS) and export standards.

3) Important problems of a so-called "external" nature include those of environment-related technology. Noise in processing (especially press work and forging) and machining stages, foul solution discharged from plating shops, and problems related to the use of oil common to all kinds of metalworking are of particular consequence to this industry which involves many smaller factories located in the midst of residential districts.

In the technological development of the Japanese bicycle industry after World War II, the Bicycle Technology Research Foundation played an important part (see chapter III.3), and, with respect to process-control techniques related to standardization, the Vehicle Inspection Society performed a central role in technology transfer through its guidance and promotional activities directed to individual manufacturers. Virtually all major manufacturers have acquired JIS qualification, and some are qualified under

foreign industrial standards on their own. Thus the bicycle industry seems to be relatively blessed with the requisites for technological development. Yet the following questionable aspects have to be pointed out.

1) There still are wide gaps — technological gaps — between stronger and weaker manufacturers. Certainly these gaps in part stem from the difference in the kind of component produced, but on the one hand major enterprises have large research staffs — having something like a ¥1,000 million annual budget for its research and development activities as well as access to technical information overseas — while on the other hand the smallest enterprises, operating at a cottage-industry level, are suffering from rising labour costs and intensifying objections to noise emission. Although there is no trend for the bicycle-parts industry as a whole to become subordinate to the finished-vehicle sector on a subcontracting basis, there does exist a trend within the parts sector for some manufacturers to become subcontractors to others.

2) The competition in the export market from late participants including Taiwan and Singapore seems to have been coped with, as in other industries, by the orthodox strategy of cost reduction through labour saving and automation, coupled with further sophistication of products. A fundamental problem may be whether or not this orthodox strategy alone can ensure success. It is true that the technological potentials and technical skills possessed by the bicycle-parts industry are up to remarkably high standards. But it is necessary to propagate these potentials to other areas or to further diversify the products of the industry. While some manufacturers are already moving ahead in this direction, institutional arrangements are needed to assess accurately the needs of today's society and provide appropriate guidance and advice based on comprehensive information.

3) The Bicycle Technology Research Foundation certainly is playing an important role, but it seems to have some problems common to many public research bodies. For example, its research staff is not large enough to effectively utilize its equipment, no conscious efforts are made on the management of research activities, and it is difficult to recruit and maintain technicians skilled in the handling of sophisticated equipment

and instruments, which therefore have to be operated by researchers. Contacts with skilled personnel in private enterprises have to be strengthened and other steps have to be taken to solve these problems.

4) Developmental activities in the so-called soft technology area are not necessarily animated. Computers probably can be used for process control, automation, and related purposes, but they will prove even more useful in such software aspects of rationalization as control of the assembling procedure and appropriate inventory control in the network of small manufacturers.

Labour saving and qualitative improvement of products are by no means unimportant, but technological problems in a broader sense of the term seem to remain unsolved in the area of business administration including production control. While a number of manufacturers may have already achieved unique results in this respect, efficient production of many different items in small lots, among other things, is likely to prove an important task to accomplish from now on, especially for small enterprises.

TABLE 1. Relative Position of the Bicycle Industry among All the Japanese Manufacturing Industries in 1977 (values of products shipped in million yen; shipped values per head in thousand yen)

	All manufacturing industries (a)	Bicycle & bicycle parts industry (b)	(b/a) Proportion of bicycle/parts industry
No. of factories	714.177	1.175	0.16 %
No. of employees	10,874.768	21.719	0.20
Values of products shipped	156,917.932	284.415	0.18
Shipped values per head	14.429	13.095	90.8

Source: Tsūsan-shō (Ministry of International Trade & Industry), Kōgyō Tōkei-hyō: Sangyō-hen (Tables of industrial statistics: classification by industry).

TABLE 2. Annual Exports by Major Bicycle-Exporting Countries
(bicycles and parts; in $1,000)

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Japan	14,092	15,359	19,019	20,599	22,459	29,795	35,427	43,811	45,970	76,202	173,571	198,293	240,125	114,186
UK	43,939	48,089	37,801	35,325	30,402	28,665	29,912	33,525	36,012	47,331	63,455	69,770	71,196	79,374
West Germany	21,207	19,276	21,477	22,595	34,150	28,074	33,913	40,039	38,204	41,964	72,060	88,519	98,435	71,857
France	13,174	13,093	15,048	14,002	13,594	15,227	16,820	19,853	27,644	41,337	89,292	98,832	107,530	85,832
Italy	8,279	7,892	8,781	9,675	11,219	13,002	19,645	25,630	24,631	34,354	63,684	66,568	71,669	63,489
Austria	-	2,699	3,831	3,312	1,979	1,760	4,843	7,835	11,448	11,119	24,701	37,029	42,301	12,439
Holland	3,550	3,881	4,045	3,932	3,742	4,422	5,941	6,055	5,507	7,715	15,078	17,892	22,669	19,485
Belgium & Luxembourg	3,805	3,276	3,501	3,368	3,979	3,678	4,281	6,103	4,601	4,853	9,888	12,254	13,726	9,008
Switzerland	-	1,036	1,317	-	1,405	1,608	2,032	2,036	2,578	3,896	5,906	6,646	8,558	5,294
Norway	913	1,049	1,608	2,703	1,926	2,630	3,168	3,352	3,579	3,726	5,666	7,618	11,313	9,912
Yugoslavia	353	288	-	-	1,506	1,636	2,015	2,287	1,507	2,797	3,644	4,638	3,959	4,844
Sweden	1,198	1,143	1,475	1,345	1,275	1,477	1,245	1,353	1,542	1,948	3,636	3,463	4,562	3,660

Source: UN trade statistics, quoted in Jitensha Sangyō Shinkō Kyōkai (Association for Promotion of the Bicycle Industry), Jitensha Tōkei Yōran (Handbook of bicycle statistics).

TABLE 3. Annual (finished) Bicycle Outputs of Major Exporting Countries (in 1,000 units)

	1957	1960	1965	1970	1971	1972	1973	1974	1975	1976	1977	1978
US	1,885	2,585	4,619	4,950	6,362	8,751	10,072	10,161	5,606	6,437	7,484	7,342
Japan	2,405	3,291	3,061	4,521	4,948	7,081	9,412	7,690	5,972	6,310	6,334	5,869
UK	2,544	2,278	1,683	1,585	1,769	1,974	2,016	1,934	1,923	1,833	1,711	2,075
West Germany	1,379	1,679	1,655	2,351	2,856	3,302	3,262	3,081	3,072	3,565	3,874	3,721
France	680	680	889	1,288	1,551	2,062	2,166	2,463	1,930	1,942	2,061	2,116
Italy	380	650	900	1,450	1,500	2,000	2,150	2,000	1,600	2,000	2,000	1,800
Holland	485	672	551	666	686	846	859	1,024	864	976	1,051	1,039
Belgium	-	* 385	280	196	216	299	283	334	425	-	343	279
Sweden	135	125	180	262	244	235	238	242	250	275	218	
Denmark	-	* 186	180	212	186	207	224	225	186	255	289	-
Austria	133	145	261	637	548	1,004	1,164	1,237	319	214	264	-
India	791	1,050	1,500	2,094	1,826	2,273	2,541	2,464	2,209	2,250	-	-
USSR	-	2,800	3,800	3,852	3,912	4,000	4,112	4,147	4,292	4,500	-	-

Note: * Figures of 1959.

Source: Jitensha Tōkei Yōran.

TABLE 4. Japan's Annual Bicycle Outputs, Exports and Imports
(number of units in thousands; and values in million yen)

Year	Output			Export			Import		
	Finished vehicles		Parts	Finished vehicles		Parts	Finished vehicles		Parts
	No. of units	Value	Value	No. of units	Value	Value	No. of units	Value	Value
1921	-	15.8	-	-	0.4		13,387	1,919	4,492
22	-	13.3	-	-	0.4		10,167	1,758	4,719
23	69	2.9	-	-	0.4		9,538	1,786	4,043
24	92	2.7	-	-	0.7		10,991	3,086	4,587
25	38	0.8	-	-	2.3		6,804	2,803	3,414
26	41	1.1	-	-	2.0		1,854	169	3,142
27	89	3.0	-	-	1.9		1,681	118	1,799
28	125	3.3	-	-	2.5		790	61	1,573
29	90	2.5	16	-	3.4		539	44	1,236
30	552	19	11	5	2.9		94	5	596
31	552	19	11	-	3.3		110	6	399
32	603	20	15	-	6.0		42	3	211
33	660	19	19	52	1.2	12	10	0.8	109
34	730	25	22	104	2.4	17	6	0.3	73
35	903	31	34	118	2.5	16	23	0.8	85
36	1,055	40	35	142	3.1	19	24	2	25
37	1,090	43	38	119	3.0	23	74	6	64
38	1,080	75	37	51	1.6	14	23	1	10
39	950	78	25	57	2.2	16	-	-	-
40	1,245	89	21	32	1.9	23	-	-	-
41	185	13	13	50	3.2	9	-	-	-
42	181	13	8	41	2.7	9	71	2	0.066
43	70	5	2	32	2.2	7	1	0.015	2.426
44	65	9	1	6	0.6	2	-	-	-
45	18	6	64	0.4	0.05	0.113	-	-	-
46	105	112	348	3	3.0	13	-	-	-
47	192	471	1,811	18	39	45	1	0.6	-
48	337	1,745	6,218	23	188	554	-	-	0.7
49	552	3,478	10,668	38	277	581	-	-	-
50	981	6,964	11,359	159	1,188	702	-	-	-
51	987	10,087	16,953	128	1,389	2,534	60	2,087	69
52	1,019	10,748	14,868	29	251	2,382	49	486	170
53	1,184	12,441	17,029	20	159	2,164	376	4,476	132
54	1,038	11,214	15,104	17	136	2,347	834	8,717	4,183
55	1,109	12,553	15,601	35	257	2,792	158	1,367	2,362
56	1,397	15,665	18,288	51	361	3,039	75	404	5,195
57	2,405	24,083	18,437	69	500	2,592	78	472	4,615
58	2,521	25,055	17,075	84	565	1,878	34	489	2,457
59	2,959	28,671	20,880	194	1,329	2,477	119	1,688	6,382
60	3,291	30,935	23,405	360	2,485	2,863	130	2,005	273
61	3,152	29,140	22,495	258	1,736	3,347	371	4,875	4,989
62	3,210	30,091	22,873	265	1,853	3,562	2,190	24,907	5,250
63	3,155	28,923	21,983	288	1,989	3,788	3,274	33,888	22,059
64	3,212	29,747	24,112	399	2,646	4,496	1,565	21,096	124,680
65	3,126	28,823	24,394	453	3,037	4,700	405	5,542	171,248
66	3,657	34,586	27,362	512	3,390	5,312	545	10,164	152,952
67	3,878	37,770	29,401	750	4,978	6,425	411	7,606	149,458
68	4,013	37,654	30,286	799	5,610	7,961	344	4,242	36,637
69	4,278	38,079	32,202	1,032	7,531	8,930	145	1,970	20,618
70	4,528	43,825	35,594	1,071	8,214	9,251	120	2,090	28,572
71	4,948	48,936	39,494	1,257	11,537	16,166	2,488	19,283	56,430
72	7,081	79,905	69,165	1,546	18,958	35,996	6,801	62,163	105,289
73	9,412	112,500	97,842	1,209	15,374	39,997	79,287	1,114,879	278,978
74	7,690	118,830	100,340	1,366	22,939	49,209	143,198	1,979,295	841,820
75	5,972	93,476	60,385	561	8,865	25,924	32,278	420,242	989,129
76	6,310	97,642	77,045	904	14,971	41,066	32,434	357,732	955,580
77	6,278	101,669	95,632	1,103	19,721	46,885	5,858	99,310	767,881
78	5,869	96,085	86,631	640	11,341	39,792	8,148	98,034	1,117,994

(Table 4 continued)

Notes:

1. Production figures: (a) those from 1921 through 1929 are based on Kōjō Tōkei (Factory statistics); (b) those from 1930 through 1944, on data compiled by Nihon Jitensha Kōgyōkai (the Japan Association of Bicycle Manufacturers); (c) those from 1945 through 1947, on Kōgyō Tōkei (Industrial statistics), and (d) those for 1948 and thereafter, on Kikai Tōkei Nempō (Annual reports on machinery statistics).

2. Export and import figures: Those from 1921 on are based on Nihon Gaikoku Tōkei Nempō (Annual reports of Japan on foreign statistics) and Nihon Gaikoku Bōeki Nempō (Annual reports of Japan on foreign trade).

3. Figures on parts in the production column include those used in finished bicycles.

4. As finished-bicycle outputs of manufacturer-wholesalers began to be counted in 1957, the number and value of finished vehicles in the production column sharply increased in that year.

5. Source: Nihon Jitensha Kōgyōkai, 30-Nen no Ayumi (30-year history), 1978; quoted in Jitensha Tōkei Yōran.

TABLE 5. Japan's Annual Output of Finished Bicycles

	Classified by Type (in 1,000 units)						The Proportions of Different Types (%)					
	Utility bicycles	Lightweight bicycles		Children's bicycles	Speciality bicycles	Total	Utility bicycles	Lightweight bicycles		Children's bicycles	Speciality bicycles	Total
		Light models	Sport models					Light models	Sport models			
Year												
1957	1,719	349		304	34	2,405	71.5	14.5		12.6	1.4	100
58	1,865	289		342	24	2,521	74.0	11.5		13.6	1.0	100
59	2,241	357		335	27	2,959	75.7	12.1		11.3	0.9	100
60	2,281	602		388	19	3,291	69.3	18.3		11.8	0.6	100
61	2,049	685		399	19	3,152	65.0	21.7		12.7	0.5	100
62	1,900	867		428	15	3,210	59.2	27.0		13.3	0.5	100
63	1,552	1,112		480	11	3,155	49.2	35.2		15.2	0.3	100
64	1,214	1,459		528	11	3,212	37.8	45.4		16.4	0.3	100
65	847	1,563		705	8	3,126	27.1	50.0		22.6	0.3	100
66	749	1,994		894	20	3,657	20.5	54.5		24.4	0.5	100
67	698	2,226		909	44	3,878	18.0	57.4		23.4	1.1	100
68	644	2,102		1,084	173	4,013	16.0	52.4		27.0	4.3	100
69	543	1,838		1,396	501	4,278	12.7	43.0		32.6	11.7	100
70	266	1,313	999	1,201	749	4,529	5.9	29.0	22.1 51.1	26.5	16.5	100
71	220	1,083	1,269	1,299	1,077	4,948	4.4	21.9	25.6 27.5	26.3	21.8	100
72	209	1,224	2,179	1,953	1,516	7,081	3.0	17.3	30.8 48.1	27.6	21.4	100
73	256	1,476	2,313	2,560	2,806	9,412	2.7	15.7	24.6 40.3	27.2	29.8	100
74	196	1,152	2,157	1,825	2,359	7,690	2.5	15.0	28.0 43.0	23.7	30.7	100
75	106	1,693	1,239	1,660	2,273(2,066)	5,972	1.8	28.3	20.7 49.0	27.8	38.1(34.6)	100
76	121	744	1,755	1,466	2,223(2,102)	6,310	1.9	11.8	27.8 39.6	23.2	35.2(33.3)	100
77	108	653	1,838	1,519	2,159(2,040)	6,278	1.7	10.4	29.3 39.7	24.2	34.4(32.5)	100
78	104	653	1,497	1,452	2,163(2,078)	5,869	1.8	11.1	25.5 36.6	24.7	36.9(35.4)	100

Notes:

1. Utility bicycles = bicycles mainly intended for conveyance of light luggage and rides for business visits, having wheels of 26 inches in nominal diameter, and weighing not less than 17 kg net of accessories; service speed, 12 to 14 kph.
2. Light models = bicycles mainly intended for rides to and from work or school, or for shopping, having wheels of 26 inches in nominal diameter, and weighing not more than 17 kg net of accessories, some having epicyclic transmission mechanisms; service speed, 14 to 16 kph.
3. Sports models = bicycles mainly intended for cycling tours and other leisure purposes, equipped with transmission mechanisms, having wheels of 26 inches in nominal diameter, and weighing not more than 17 kg net of accessories; service speed, 16 to 20 kph.
4. Children's bicycles = bicycles designed for children's use, having wheels of 12 to 24 inches in nominal diameter.
5. Specialty bicycles = bicycles not belonging to any of the foregoing categories, such as mini-cycles, high-risers, heavy-load carriers, bicycles to be equipped with motors, collapsible bicycles, and tandem bicycles.
6. Parenthesized figures in the specialty bicycles column for 1975 and thereafter refer to mini-cycles.
7. Mini-cycles = bicycles having the mechanisms of adults' models but not exceeding 24 inches in nominal wheel diameter, including collapsible and take-down types. High-risers = a specific type of bicycle for children, having wheels of not more than 24 inches in nominal diameter with thick tyres.
8. Tsūsan-shō, Kikai Tōkei Nempo (Annual reports on machinery statistics), quoted in Jitensha Tōkei Yōran.

TABLE 6. Japan's Annual Bicycle-Parts Output Classified by Item (in million yen)

	1950	1955	1960	1965	1970	1971	1972	1973	1974	1975	1976	1977	1978
Frame	2,759	3,237	6,951	6,325	7,858	7,142	10,313	15,429	15,141	10,423	10,961	16,555	14,619
Mudguards	526	652	871	1,082	1,539	1,554	1,754	3,273	2,866	2,447	2,581	2,285	1,920
Chain wheel & cranks	634	902	972	1,306	2,255	2,797	4,316	5,891	4,689	3,761	5,506	7,494	7,202
Handlebars	831	1,144	1,398	1,598	2,786	2,951	3,613	4,630	4,110	3,426	3,887	4,212	3,735
Hub brake			919	535	1,068	1,066	1,392	1,990	2,075	2,069	1,930	2,076	2,125
Calliper brakes	603	1,148	141	861	1,024	2,155	5,850	6,904	8,368	3,775	6,591	7,461	7,211
Rim brakes			524	366	574	414	708	695	665	304	399	365	352
Rims	1,177	2,111	2,786	2,168	3,074	3,944	5,559	6,441	5,679	5,167	5,255	6,551	6,247
Spokes	366	567	741	705	1,370	1,430	1,943	2,843	3,063	2,645	3,214	3,377	2,973
Hubs	761	1,080	1,228	1,272	2,823	2,764	4,880	6,535	9,918	4,611	8,527	11,078	8,823
Free wheel	431	699	831	683	1,039	1,086	2,722	6,674	8,727	3,537	5,895	7,559	6,707
Transmission	-	-	913	2,203	2,020	3,010	13,533	21,997	19,207	6,970	8,372	10,460	9,809
Pedals	455	434	779	737	1,274	1,379	2,652	2,704	3,124	2,266	2,858	3,311	3,141
Saddle	926	1,090	1,222	1,166	1,988	2,305	2,604	2,938	2,925	2,230	2,580	2,646	2,498
Gear case	564	688	933	823	1,120	1,260	1,325	1,388	1,478	1,512	1,496	2,022	1,567
Chain	537	774	897	1,140	1,683	1,944	2,553	3,487	3,955	1,999	3,194	3,546	3,404
Luggage carrier	120	283	461	573	1,092	1,448	2,147	2,100	2,284	1,694	1,961	2,480	2,352
Stand	151	434	559	562	796	901	970	1,356	1,552	1,188	1,368	1,686	1,548
Bell	254	359	280	289	424	-	331	567	514	361	470	468	398
Total of all parts	11,359	15,601	23,405	24,394	35,807	39,494	69,163	97,842	100,340	60,385	77,045	95,632	86,631

Source: Jitensha Tōkei Yōran.

TABLE 7. Japan's Annual Bicycle-Parts Output Classified by Item (percentage)

	1950	1955	1960	1965	1970	1971	1972	1973	1974	1975	1976	1977	1978
Frame	24.3	0.7	29.7	25.9	21.9	18.1	14.9	15.8	15.1	17.3	14.2	17.3	16.9
Mudguards	4.6	4.2	3.7	4.4	4.3	3.9	2.5	3.3	2.9	4.1	3.3	2.4	2.2
Chain wheel & cranks	5.6	5.8	4.2	5.4	6.3	7.1	6.2	6.0	4.7	6.2	7.1	7.8	8.3
Handlebars	7.3	7.3	6.0	6.6	7.8	7.5	5.2	4.7	4.1	5.7	5.0	4.4	4.3
Hub brake	} 5.3	} 7.4	3.9	2.2	3.0	2.7	2.0	2.0	2.1	3.4	2.5	2.2	2.5
Calliper brakes			0.6	3.5	2.9	5.5	8.5	7.1	8.3	6.3	8.6	7.8	8.3
Rim brakes			2.2	1.5	1.6	1.0	1.0	0.7	0.7	0.5	0.5	0.4	0.4
Rims	10.4	13.5	11.9	8.9	8.6	10.0	8.0	6.6	5.7	8.6	6.8	6.9	7.2
Spokes	3.2	3.6	3.2	2.9	3.8	3.6	2.8	2.9	3.1	4.4	4.2	3.5	3.4
Hubs	6.7	6.9	5.2	5.2	7.9	7.0	7.1	6.7	9.9	7.6	1.1	11.6	10.2
Free wheel	3.8	4.5	3.6	2.8	2.9	2.7	3.9	6.8	8.7	5.9	7.7	7.9	7.7
Transmission	—	—	3.9	9.0	5.6	7.6	19.6	22.5	19.1	11.5	10.9	10.9	11.3
Pedals	4.0	2.8	3.3	3.0	3.6	3.5	3.8	2.8	3.1	3.8	3.7	3.5	3.6
Saddle	8.2	7.0	5.2	4.8	5.6	5.8	3.8	3.0	2.9	3.7	3.3	2.8	2.9
Gear case	5.0	4.4	4.0	3.4	3.1	3.2	1.9	1.4	1.5	2.5	1.9	2.1	1.8
Chain	4.7	5.0	3.8	4.7	4.7	4.9	3.7	3.6	3.9	3.3	4.1	3.7	3.9
Luggage carrier	1.1	1.8	2.0	2.3	3.0	3.7	3.1	2.1	2.3	2.8	2.5	2.6	3.7
Stand	1.3	2.8	2.4	2.3	2.2	2.3	1.4	1.4	1.5	2.0	1.8	1.8	1.8
Bell	2.2	2.3	1.2	1.2	1.2	—	0.5	0.6	0.5	0.6	0.6	0.5	0.5
Total of all parts	100	100	100	100	100	100	100	100	100	100	100	100	100

Source: Jitensha Tōkei Yōran.

TABLE 8. Japan's Annual Bicycle-Parts Exports Classified by Item (in $1,000)

	1957	1960	1965	1970	1971	1972	1973	1974	1975	1976	1977	1978
Frame	226	278	243	693	695	2,186	3,043	4,247	2,061	3,627	4,408	6,129
Chain wheel & cranks	713	441	506	637	819	3,624	4,777	6,648	5,141	10,871	13,847	16,250
Handlebars	439	404	425	897	1,020	1,485	1,795	2,481	1,881	1,940	2,119	2,524
Brakes	255	350	1,131	2,089	5,819	17,168	22,910	23,591	8,225	15,128	19,596	21,458
Rims	388	640	1,249	1,901	3,034	5,167	5,983	6,488	5,239	4,511	5,579	5,090
Spokes	54	73	124	789	898	1,702	3,546	3,403	1,351	1,973	2,512	1,915
Hubs	109	231	1,907	2,735	6,035	19,516	26,276	24,173	11,535	22,614	29,538	29,213
Free wheel	314	410	722	1,328	3,825	9,696	13,338	16,270	7,895	11,125	13,922	14,078
Chain	639	515	655	2,265	2,863	4,438	5,594	6,816	2,715	5,194	7,439	6,360
Pedals	176	278	287	353	389	1,121	1,023	1,635	1,862	2,813	3,243	3,738
Saddle	601	519	570	1,895	2,736	4,711	2,551	2,793	1,593	2,346	2,538	2,345
Bell	401	340	241	293	232	420	215	340	332	540	552	364
Other items	2,946	3,375	4,996	9,823	18,271	45,644	56,208	71,066	37,435	55,953	69,914	79,358
(Front forks)	-	-	355	505	658	998	1,133	1,941	875	-	-	-
(Mudguards)	274	224	234	314	341	449	488	649	566	-	-	-
(Gear case)	181	147	181	255	364	484	564	774	888	-	-	-
(Luggage carrier & stand)	147	102	155	394	643	2,471	1,386	1,811	991	-	-	-
(Others)	2,124	2,902	4,071	8,355	16,265	41,242	52,637	65,891	34,115	-	-	-
Total of all parts	7,261	7,955	13,056	25,698	46,635	116,876	147,259	169,939	87,264	138,435	175,205	188,821
Denominated in (million) yen	2,614	2,863	4,700	9,251	16,166	35,996	39,997	49,209	25,924	41,066	46,885	39,792

Note: Customs clearance statistics of the Customs and Tariff Bureau, Ministry of Finance (denominated in yen), translated into dollars; quoted in Jitensha Tōkei Yōran.

TABLE 9. Japan's Annual Bicycle Exports (finished vehicles and parts) Classified by Region of Destination (in $1,000)

		1957	1960	1965	1970	1971	1972	1973	1974	1975	1976	1977	1978
Absolute sum (in thousand dollars)	Southeast Asia	5,936	7,115	6,511	12,945	13,804	20,057	28,105	25,537	21,504	27,713	34,497	34,404
	Near & Middle East	316	774	880	898	856	1,135	1,670	1,942	3,298	4,899	7,178	6,824
	Europe	62	156	507	1,660	2,396	15,190	15,771	14,126	12,451	25,265	36,147	44,532
	North America	270	3,428	9,517	24,859	55,240	129,882	142,662	185,087	60,056	101,972	130,682	114,097
	Latin America	698	942	1,685	2,868	3,187	5,876	7,391	8,850	7,743	13,069	20,643	19,946
	Africa	1,288	2,220	1,707	2,102	2,070	1,803	1,918	3,421	4,273	4,973	8,130	5,775
	Oceania	23	224	683	3,180	2,234	4,485	5,735	9,846	7,743	10,956	10,908	14,311
	Total	8,540	14,858	21,491	48,513	79,786	178,429	203,251	248,810	117,067	188,846	248,201	239,889
Share (in %)	Southeast Asia	69.5	47.9	30.3	26.7	17.3	11.2	13.8	10.3	18.4	14.7	13.9	14.3
	Near & Middle East	3.7	5.2	4.1	1.9	1.1	0.6	0.8	0.8	2.8	2.6	2.9	2.8
	Europe	0.7	1.0	2.4	3.4	3.0	8.5	7.8	5.7	10.6	13.4	14.6	18.6
	North America	3.2	23.1	44.3	51.2	69.2	72.8	70.2	74.4	51.3	54.0	52.7	47.6
	Latin America	8.2	6.3	7.8	5.9	4.0	3.3	3.6	3.6	6.6	6.9	8.3	8.3
	Africa	15.1	14.9	7.9	4.3	2.6	1.0	0.9	1.4	3.7	2.6	3.3	2.4
	Oceania	0.3	1.5	3.2	6.6	2.8	2.5	2.8	4.0	6.6	5.8	4.4	6.0
	Total	100	100	100	100	100	100	100	100	100	100	100	100

Source: The same as Table 8.

TABLE 10. Japan's Annual Bicycle Exports (finished vehicles and parts) Classified by Country of Destination (in $1,000)

Country	1957	1960	1965	1970	1971	1972	1973	1974	1975	1976	1977	1978
US	227	3,249	9,071	20,723	46,211	107,066	124,705	165,436	45,832	78,758	109,962	100,073
Canada	43	178	446	4,136	9,029	22,816	17,957	19,651	14,224	23,214	20,720	14,024
Taiwan	157	183	197	283	848	7,513	10,348	5,009	3,350	7,533	8,955	11,109
West Germany	2	19	91	687	994	5,691	2,846	2,527	2,596	4,966	6,567	9,381
Indonesia	1,833	865	687	6,979	7,305	4,234	4,330	5,553	7,241	4,023	4,639	2,604
Australia	12	120	514	3,026	1,983	3,939	5,132	8,916	7,157	10,101	9,767	12,447
Austria	-	-	-	46	91	2,635	5,236	3,412	86	829	548	504
Singapore	551	1,175	619	1,745	2,089	1,776	1,394	2,580	1,831	2,869	2,601	2,593
Sweden	3	-	3	22	22	1,636	471	149	208	446	1,356	2,743
Thailand	1,088	1,233	1,686	1,162	816	1,462	1,497	1,835	2,887	2,523	3,475	3,461
Total (including other countries)	8,540	14,858	21,491	48,513	79,786	178,429	203,251	248,810	117,067	188,846	248,201	239,889

Source: The same as Table 8.

TABLE II. Ratios of Finished Bicycles to Parts in Annual Exports from Japan, Classified by Region of Destination (in %)

		1957	1960	1965	1970	1971	1972	1973	1974	1975	1976	1977	1978
Southeast Asia	Finished	15	23	15	44	36	13	9	10	10	10	10	5
	Parts	85	77	85	56	64	87	91	90	90	90	90	95
Near & Middle East	Finished	24	47	55	61	52	50	49	47	50	65	76	66
	Parts	76	53	45	39	48	50	51	53	50	35	24	34
Europe	Finished	0	2	5	3	1	0	1	0	1	1	5	5
	Parts	100	98	95	97	99	100	99	100	99	99	95	95
North America	Finished	4	66	58	58	47	43	36	39	36	38	43	31
	Parts	96	34	42	42	53	57	64	61	64	62	57	69
Latin America	Finished	13	33	52	40	35	23	15	17	18	10	9	10
	Parts	87	67	48	60	65	77	85	83	82	90	91	90
Africa	Finished	25	30	24	37	26	20	10	12	22	31	32	45
	Parts	75	70	76	63	74	80	90	88	78	69	68	55
Oceania	Finished	36	38	21	7	5	9	5	12	25	18	18	17
	Parts	64	62	79	93	95	91	95	88	75	82	82	83
Total	Finished	16	34	39	47	42	34	28	32	25	27	29	21
	Parts	84	66	61	53	58	66	72	68	75	73	71	79

Source: The Customs and Tariff Bureau, Ministry of Finance; quoted in Jitensha Tōkei Yōran.

TABLE 12. Values of Japan's Annual Bicycle Exports (finished vehicles and parts) to Semideveloped Nations in Asia (in $1,000)

		1957	1960	1965	1970	1971	1972	1973	1974	1975	1976	1977	1972
ROK	Finished	5	205	31	9	22	500	895	348	-	36	33	53
	Parts	85	94	20	39	236	828	5,264	3,425	2,256	4,976	7,717	8,328
	Total	90	298	51	47	258	1,327	6,159	3,772	2,256	5,012	7,749	8,381
	Share of parts (%)	95.6	31.5	39.2	83.0	91.5	62.4	85.5	90.8	100	99.3	99.6	99.4
Taiwan	Finished	2	1	-	4	0	2	356	11	1	-	-	-
	Parts	115	182	197	279	848	7,510	9,993	4,998	3,349	7,533	8,955	11,109
	Total	117	183	197	283	848	7,513	10,348	5,009	3,350	7,533	8,955	11,109
	Share of parts (%)	98.3	99.5	100	98.6	100	100	96.6	99.8	100	100	100	100
Hong Kong	Finished	7	8	27	69	102	884	71	53	59	36	12	173
	Parts	98	66	81	65	79	197	981	1,435	325	448	371	710
	Total	105	74	108	134	181	1,081	1,052	1,487	384	483	383	882
	Share of parts (%)	93.3	89.2	75.0	48.5	43.6	18.2	93.3	96.5	84.6	92.8	96.9	80.5

Source: The Customs and Tariff Bureau, Ministry of Finance; quoted in Jitensha Tōkei Yōran.

TABLE 13. Competitive Situation of Imported Finished Bicycles in the US Market

			Import source				Share of each (%)			
			Japan	Taiwan	ROK	Total import	Japan	Taiwan	KOR	Total import
Number of finished bicycles	24-inch & below	1971	185,541	101,814	5,988	779,766	23.8	13.1	0.8	100
		1975	37,934	219,262	82,009	527,162	7.2	41.6	15.6	100
		1976	29,686	340,406	84,527	622,544	4.8	54.7	13.6	100
	26-inch & above	1971	500,461	2,350	10,375	1,558,704	32.1	0.2	0.7	100
		1975	258,837	145,310	59,274	1,182,285	21.9	12.3	5.0	100
		1976	436,000	225,940	90,514	1,039,902	41.9	21.7	8.7	100
	Total	1971	686,002	104,164	16,363	2,338,470	29.3	4.5	0.7	100
		1975	296,771	364,572	141,283	1,709,447	17.4	21.3	8.3	100
		1976	465,586	566,346	175,041	1,662,446	28.0	34.1	10.5	100
Value of finished bicycles (in $1,000)	24-inch & below	1971	3,646	1,619	104	14,055	25.9	11.5	0.7	100
		1975	2,286	6,189	2,170	16,350	14.0	37.9	13.3	100
		1976	1,472	9,608	2,259	17,685	8.3	54.3	12.8	100
	26-inch & above	1971	13,818	53	192	49,214	28.1	0.1	0.4	100
		1975	16,673	5,361	2,264	73,824	22.6	7.3	3.1	100
		1976	26,068	8,284	3,111	59,280	44.0	14.0	5.6	100
	Total	1971	17,464	1,672	296	63,269	27.6	2.6	0.5	100
		1975	18,959	11,550	4,434	90.174	21.0	12.8	4.9	100
		1976	27,540	17,892	5,370	76,965	35.8	23.2	7.0	100

Source: US Department of Commerce statistics FT 153, Schedule A code: 7331120, 7331140; quoted in Toshio Shibata, "Higashi Ajia Chūshinkoku no Yushutsu Shinchō to Wagakuni Chūshō Kigyō, Case Study 4, Jitensha Dōbuhin," in Nihon Bōeki Shinkō-kai, Kaigai Shijō, XXVIII, 322, 1 August 1978, pp. 52-53 (see note 15 to the text).

TABLE 14. Competitive Situation of Imported Bicycle Parts in the US Market (values in $1,000; shares in %)

	1971		1975		1976	
	Value	Share	Value	Share	Value	Share
Japan	19,070	53.0	25,775	55.6	44,779	61.4
Taiwan	146	0.4	1,507	3.3	2,434	3.3
ROK	199	0.6	123	0.3	350	0.5
Hong Kong	279	0.8	415	0.9	207	0.3
France	4,772	13.3	4,393	9.5	5,856	8.0
West Germany	5,254	14.6	3,407	7.4	5,458	7.5
Italy	1,134	3.2	2,925	6.3	2,073	2.8
UK	2,300	6.4	1,529	3.3	1,455	2.0
Switzerland	1,425	4.0	735	1.6	1,436	2.0
Mexico	62	0.2	4,034	8.7	6,799	9.3
Total import	35,978	100	46,339	100	72,994	100

Source: The same as Table 13, Schedule A code: 7331200.

TABLE 16. Japan's Bicycle and/or Parts Factories in 1977, Classified by Work Force Size

No. of employees per factory	No. of factories		No. of employees		Value of products shipped (in million yen)	
	Absolute number	%	Absolute number	%	Absolute sum	%
9 or less	783	66.6	3,433	15.8	16,715	5.9
10 - 19	174	14.8	2,418	11.1	22,386	7.9
20 - 29	79	6.7	1,909	8.8	21,404	7.5
30 - 49	63	5.4	2,393	11.0	25,323	8.9
50 - 99	43	3.7	2,995	13.8	38,880	13.7
100 - 299	24	2.0	3,849	17.7	73,607	25.9
300 - 499	6	0.5	2,313	10.6	28,811	10.1
500 or more	3	0.3	2,409	11.1	57,284	20.1
Total	1,175	100	21,719	100	284,415	100

Source: Tsusan-sho, Kōgyō Tōkei-hyō: Sangyō-hen.

TABLE 15. Japan's Finished-Bicycle and Parts Imports in 1978 Classified by Geographical Source (quantities in numbers of bicycles; sums in 1,000 yen; unit price in yen)

	Finished bicycles									Total of parts	Grand total sum
	With transmission			Others			Total				
	Qtty.	Sum	Unit price	Qtty.	Sum	Unit price	Qtty.	Sum	Unit price		
ROK	-	-	-	224	2,805	12,522	224	2,805	12,522	52,577	55,382
Taiwan	822	9,379	11,410	4,455	39,209	8,801	5,277	48,588	9,208	251,663	300,251
Singapore	-	-	-	-	-	-	-	-	-	388,477	388,477
UK	-	-	-	1	234	234,000	1	234	234,000	18,421	18,655
Holland	-	-	-	-	-	-	-	-	-	514	514
Belgium	-	-	-	-	-	-	-	-	-	1,498	1,498
France	50	4,134	82,680	1	476	476,000	51	4,610	90,392	170,929	175,539
West Germany	2	164	82,000	4	264	66,000	6	428	71,333	423	851
Switzerland	-	-	-	-	-	-	-	-	-	3,272	3,272
Spain	-	-	-	-	-	-	-	-	-	2,483	2,483
Italy	147	19,007	129,299	20	1,453	72,650	167	20,460	122,515	210,337	230,797
Finland	1	1.31	131,000	-	-	-	1	1.31	131,000	-	131
US	-	-	-	2,411	20,400	8,461	2,411	20,400	8,461	17,400	37,800
Mexico	3	378	126,000	-	-	-	3	378	126,000	-	378
Total	1,025	33,193	32,383	7,116	64,841	9,112	8,141	98,034	12,042	1,117,994	1,216,028

Source: Customs and Tariff Bureau, Ministry of Finance; quoted in Jitensha Tōkei Yōran.

TABLE 17. Prefectural Breakdown of Bicycles and Parts Shipped Out of Japanese Factories in 1977
(in million yen; percentage of shares in parentheses)

		Saitama	Tokyo	Aichi	Osaka	National Total	Prefectures each having only one or two factories and therefore not listed
Finished bicycles	Utility vehicles	12,803 (37.9)	330 (1.0)	450 (1.3)	9,826 (29.1)	33,783 (100)	Fukushima, Ibaraki, Chiba, Kanagawa, Mie, Hyōgo, Saga
	Children's vehicles	- (-)	1,241 (15.6)	994 (12.5)	772 (9.7)	7,950 (100)	Fukushima, Saitama, Chiba, Kanagawa, Nagano, Hyōgo, Saga
	Light, sport, and specialty vehicles	2,412 (5.3)	13,298 (29.2)	5,758 (12.6)	4,489 (9.9)	45,571 (100)	Miyagi, Fukushima, Chiba, Kanagawa, Nagano, Gifu, Mie, Hyōgo, Wakayama, Saga, Miyazaki, Okinawa
	Total	15,215 (17.4)	14,869 (17.0)	7,202 (8.2)	15,087 (17.3)	87,304 (100)	
Bicycle frame (finished only)		- (-)	1,112 (7.1)	573 (3.7)	8,742 (55.8)	15,680 (100)	Miyagi, Fukushima, Saitama, Chiba, Kanagawa, Nagano, Hyōgo, Saga
Bicycle parts, fittings, accessories		6,289 (3.7)	11,951 (7.0)	14,097 (8.3)	101,362 (59.4)	170,703 (100)	For parts-producing prefectures, see Table 18.
Grand total		21,504 (7.9)	27,932 (10.2)	21,872 (8.0)	125,191 (45.7)	273,687 (100)	

Source: Tsūsan-shō, Kōgyo Tōkei-hyō: Hinmoku-hen (classification by item).

TABLE 18. Prefectural Breakdown of Bicycle Parts, Fittings, and Accessories Shipped Out in 1977

	Sum (in million yen)	Share (%)
National total	170,703	100
Fukushima	1,118	0.7
Ibaraki	2,356	1.4
Tochigi	536	0.3
Gumma	1,408	0.8
Saitama	6,289	3.7
Chiba	206	0.1
Tokyo	11,951	7.0
Kanagawa	1,114	0.7
Niigata	82	0.0
Ishikawa	6,318	3.7
Nagano	2,528	1.5
Gifu	4,225	2.5
Shizuoka	2,557	1.5
Aichi	14,097	8.2
Mie	186	0.1
Shiga	2,517	1.5
Osaka	101,362	59.4
Hyōgo	1,539	0.9
Nara	2,014	1.2
Yamaguchi	5,174	3.0

Notes: 1. Prefectures each having only one or two factories and therefore not listed are:
Hokkaido, Miyagi, Yamagata, Toyama, Fukui, Kyoto, Shimane, Okayama, Hiroshima, Tokushima, Kagawa, Fukuoka, Saga, and Kumamoto.

2. Source: Tsūsan-shō, Kōgyō Tōkei-hyō: Hinmoku-hen.

TABLE 19. Changes in Number of Bicycle and Bicycle-Parts Factories in Japan, Classified by Item

		1958	1960	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Finished bicycles		192	174	136	130	125	107	109	105	100	97	97	89	73	70	71	72	69	68	68
Parts	Frame	93	73	52	50	49	50	46	40	41	47	44	40	32	33	33	34	32	32	32
	Mudguards	26	24	21	18	18	19	19	19	18	19	18	14	16	16	14	15	13	13	11
	Chain wheel & cranks	18	19	16	15	15	17	16	16	15	14	14	15	14	13	13	12	13	12	11
	Handlebars	27	23	17	18	17	16	15	16	16	15	15	12	12	10	11	11	11	10	10
	Brakes (of all kinds)	38	39	24	17	16	27	22	23	13	23	21	19	20	18	19	19	19	18	16
	Rims	16	14	10	9	7	9	9	9	8	8	8	8	8	8	9	9	8	8	8
	Spokes	7	7	7	7	7	7	6	6	6	6	6	6	6	5	5	5	5	4	3
	Hubs	35	31	19	13	11	11	11	8	8	7	7	7	7	7	8	8	7	7	7
	Free wheel	8	9	6	6	6	5	5	5	5	4	4	4	3	3	3	3	3	3	3
	Transmission	9	5	4	4	4	4	4	4	4	3	3	3	3	3	2	2	2	2	2
	Chain	9	10	8	7	7	7	7	6	6	5	5	6	5	5	5	5	5	5	4
	Pedals	13	13	12	9	9	8	7	7	8	7	7	7	7	7	7	7	7	6	6
	Saddle	19	19	12	12	11	10	9	10	10	9	9	10	10	10	10	8	7	7	7
	Gear case	19	15	13	13	13	12	10	10	9	10	10	7	6	6	6	5	6	6	3
	Luggage carrier	35	35	29	29	28	27	24	23	24	22	21	18	14	14	14	13	17	19	12
	Stand	40	37	30	29	28	29	27	25	25	25	25	19	13	13	13	12	15	17	12
	Bell	15	12	9	9	9	9	8	8	7	7	7	10	6	6	3	3	6	6	4
Total of parts factories		-	-	197	186	179	170	173	163	158	154	147	142	181	177	175	171	175	175	151

Notes: 1. Source: Tsūsan-shō, Zenkoku Kikai Kōjō Meibo (National directory of machinery factories). Figures are taken as of October every year; those for 1972 and thereafter include data derived from the Japan Association of Bicycle Manufacturers.

2. Factories referred to are those having at least ten employees each.

3. Because some factories produce two or more items each, the totals of the itemized figures are not necessarily consistent with the totals at the bottom of the table.

4. Parts for house-consumption are not counted from 1972 on.

5. Quoted in Jitensha Tōkei Yōran.

TABLE 20. Bicycles Owned in Japan (in thousand units)

Year	Bicycles owned	Year	Bicycles owned	Year	Bicycles owned
1913	418	1935	7,304	1957	16,005
14	608	36	7,722	58	16,815
15	684	37	7,878	59	18,158
16	874	38	8,305	1960	19,559
17	1,064	39	8,311	61	20,785
18	1,258	1940	8,195	62	21,952
19	1,596	41	8,361	63	22,931
1920	2,052	42	8,618	64	23,765
21	2,318	43	8,613	65	24,377
22	2,802	44	8,556	66	25,430
23	3,192	45	5,686	67	26,375
24	3,648	46	6,276	68	27,330
25	4,102	47	6,939	69	28,241
26	4,370	48	8,013	1970	29,291
27	4,751	49	9,192	71	30,497
28	5,025	1950	10,859	72	33,542
29	5,318	51	11,693	73	39,087
1930	5,779	52	12,406	74	42,151
31	6,000	53	13,270	75	43,930
32	6,356	54	13,667	76	45,555
33	6,524	55	13,928	77	46,797
34	6,895	56	15,647		

Notes:
1. Sources: Surveys by the Ministry of the Interior for 1913-1946; estimates by the Research and Statistics Department, MITI, for 1947 and thereafter.
2. The numbers of bicycles were based on those of taxable bicycles until 1957 when the bicycle tax was abolished.
3. The figures for 1958 and thereafter are estimates based on output, domestic supply, and numbers of scrapped bicycles.

TABLE 21. Comparison of Prewar and Postwar Composition of the Bicycle Industry, Based on Classification by Number of Employees per Factory

No. of employees per factory	1937		1947	
	No. of factories	Share (%)	No. of factories	Share (%)
5 - 9	484	57.1	327	33.0
10 - 14	120	14.2	186	18.7
15 - 29	120	14.2	231	23.3
30 - 49	62	7.3	110	11.1
50 - 99	39	4.6	69	7.0
100 - 199	12	1.4	34	3.4
200 - 499	8	1.0	22	2.2
500 - 999	2	0.2	13	1.3
Total	847	100	992	100

Source: Tsūsan-shō, Kōgyō Tōkei-hyō, quoted in A Century, p. 364.

TABLE 22. Sums Granted under the Bicycle Industry Promotional Subsidy System (in thousand yen)

Year	Purposes					
	Improvement of production techniques	Promotion of export	Rationalization of bicycle industry	Loans to bicycle manufacturers	Others	Total
1949	3,000	-	-	-	-	3,000
50	41,500	76,330	70,000	-	12,170	200,000
51	65,240	78,000	20,000	350,000	8,110	521,350
52	128,000	69,000	15,000	400,000	7,789	619,789
53	122,633	55,858	10,031	400,000	10,855	599,377
54	63,802	50,260	29,260	100,000	-	243,322
55	92,000	96,000	49,000	-	3,000	240,000
56	125,700	80,600	185,900	-	-	392,200
57	202,526	114,550	64,060	-	-	381,136
58	217,125	148,680	192,170	-	-	557,975
59	85,429	132,100	324,730	-	-	542,259
60	166,063	222,960	232,209	-	-	621,232
61	120,010	218,350	143,900	55,000	-	537,260
62	211,140	187,313	361,775	65,000	-	825,228
63	344,680	119,900	358,430	15,000	-	838,010
64	313,300	162,700	441,000	-	-	917,000
65	807,214	229,644	177,817	100,000	-	1,314,675
66	896,060	279,160	295,780	125,000	-	1,596,000
67	985,839	418,166	149,995	200,000	-	1,754,000
68	933,692	530,258	246,283	200,000	-	1,910,233
69	967,950	481,631	185,419	300,000	-	1,935,000
70	736,607	351,155	818,224	300,000	-	2,205,986
71	783,090	478,027	1,058,368	50,000	-	2,369,485
72	1,058,708	262,706	688,241	150,000	-	2,159,655
73	758,079	218,577	696,642	170,000	-	1,843,298
74	1,522,616	234,081	590,762	100,000	-	2,447,459
75	1,486,127	239,006	665,381	150,000	-	2,540,514
76	1,738,605	212,347	640,611	200,000	-	2,791,563
77	1,803,682	210,716	584,825	300,000	-	2,899,223
78	1,681,567	252,761	656,037	400,000	-	2,990,365
Total of 1949-1978	18,461,984	6,210,836	9,951,850	4,130,000	41,924	38,796,594

Source: Nihon Jitensha Kōgyōkai, 30-Nen no Ayumi, May 1978.

TABLE 23. Statistics on Japanese Bicycle and Bicycle-Parts Manufacturers, Classified by Number of Employees per Factory

	No. of employees per factory	Absolute values (in million yen)					Shares (%)				
		1960	1965	1970	1975	1977	1960	1965	1970	1975	1977
No. of factories	9 or less	536	496	474	852	783	51.1	58.8	60.8	68.9	66.6
	10 - 29	300	208	179	246	253	28.6	24.6	23.0	19.9	21.5
	30 - 49	93	58	43	53	63	8.9	6.9	5.5	4.3	5.4
	50 - 99	80	50	47	49	43	7.6	5.9	6.0	4.0	3.7
	100 - 299	33	24	29	26	24	3.1	2.8	3.7	2.1	2.0
	300 or more	6	8	7	10	9	0.6	0.9	0.9	0.8	0.8
	Total	1,048	844	779	1,236	1,175	100	100	100	100	100
No. of employees	9 or less	2,051	2,246	2,196	3,619	3,433	8.5	11.9	11.8	15.7	15.8
	10 - 29	2,700	3,588	3,108	4,145	4,327	11.2	19.0	16.8	18.0	19.9
	30 - 49	6,020	2,217	1,683	2,055	2,393	24.9	11.7	9.1	8.9	11.0
	50 - 99	5,373	3,478	3,312	3,383	2,995	22.2	18.4	17.9	14.7	13.8
	100 - 299	5,340	3,558	4,372	4,266	3,849	22.1	18.8	23.6	18.5	17.7
	300 or more	2,644	3,868	3,867	5,530	4,722	10.9	20.4	20.9	24.0	21.7
	Total	24,198	18,932	18,538	22,998	21,719	100	100	100	100	100
Value of products shipped	9 or less	1,862	2,788	5,905	14,052	16,715	4.8	5.6	5.9	6.2	5.9
	10 - 29	7,157	8,144	14,230	32,189	43,790	18.4	16.3	14.3	14.3	15.4
	30 - 49	5,036	5,339	7,487	20,174	25,323	12.9	10.7	7.5	9.0	8.9
	50 - 99	8,804	8,348	18,613	38,685	38,880	22.6	16.7	18.7	17.2	13.7
	100 - 299	9,387	10,625	27,448	46,600	73,607	24.1	21.3	27.6	20.7	25.9
	300 or more	6,713	14,677	25,906	73,212	86,095	17.2	29.4	26.0	32.6	30.3
	Total	38,959	49,926	99,588	224,912	284,415	100	100	100	100	100

Source: Tsūsan-shō, Kōgyō Tōkei-hyō.

NOTES

1. According to industrial statistics, the manufacturers of bicycles and/or bicycle parts in 1977 had altogether 1,175 offices and factories with 21,719 employees, and shipped out products totalling ¥284,400 million in value. In any one of these respects, the bicycle sector held a less than 0.2 per cent share in the whole manufacturing industry. For further details, see Table 1.

2. According to UN trade statistics, bicycle exports (including parts) from Japan totalled $114.19 million in 1975. The world major bicycle-exporting countries, following Japan, are France, the UK, West Germany, and Italy. For further details, see Table 2.

3. The number of finished bicycles manufactured in Japan in 1978 was 5.9 million, second only to the 7.3 million manufactured in the US. The other major bicycle-producing countries are mostly in western Europe, such as West Germany, France, the UK, and Italy. The Soviet Union and India now produce more than Britain, once the king of the bicycle-manufacturing world. For further details, see Table 3. Recently Taiwan and the Republic of Korea have been rapidly expanding their bicycle output and becoming major competitors of Japan in the US market. See chapter 1.3.

4. Ryūtsū Keizai Kenkyūjo, Jitensha Ryūtsū Bumon no Jittai Chōsa Jigyō Hōkokusho [A report on the research project on the situation of the bicycle-marketing sector], 1972, p. 149.

5. Tetsuo Minato, "Jitensha" [Bicycles] in Chūshō Kigyō Kin'yū Kōko Chōsa-bu, Ōsaka-fu ni okeru Shuyō Chūshō Kigyō no Kihon Kōzō to Mondaiten [Basic structures of and problems in main medium- and small-scale enterprises in Osaka Prefecture], Part 2, V, p. 59. The book will hereinafter be referred to as Problems.

6. Jitensha Sangyō Shinkō Kyōkai, Jitensha no Isseiki: Nihon Jitensha Sangyōshi [A century of bicycles: a history of the bicycle industry in Japan], 1973, p. 466. The book will hereinafter be referred to as A Century.

7. Ibid., p. 448.

8. Problems, pp. 60-61.

9. Ibid., p. 62.

10. Ibid.

11. Bicycle parts are classified by various criteria.

a. As constituent elements of a bicycle as a machine, they are classified into the following four categories. (1) Power receiving parts: pedals, cranks. (2) Power transmitting parts: chain sprocket, chain, free wheel or hub sprocket. (3) Working parts: wheels (hubs, spokes, rims, tyres). (4) Supporting parts: skeleton frame, front forks, saddle, handlebars.

b. The Japanese Industrial Standards classify bicycle parts into the following five categories according to the position in which they are used. (1) Body: skeleton frame, seat pillar, seat pillar pin, lamp bracket, front forks, head set, bottom bracket set, mudguards. (2) Driving mechanism: chain wheel and cranks, free wheel, pedals, chain. (3) Braking and steering mechanisms: rim brakes, hub brake, handle, handle grips, saddle. (4) Wheels: rims, spokes, hubs, tyres, inner tubes. (5) Others: crank cotter pin, chain adjusting bolt, gear case, bell, luggage carrier, stand, reflectors, air pump, lock dynamo lighting set. Jitensha Sangyō Shinkō Kyōkai, Jitensha Jitsuyō Binran [Practical handbook of bicycles], 3rd ed., 1977, pp. 12, 19.

c. There was a report in 1961 classifying bicycle parts into three categories - a small variety of mass-produced items, a large variety of items produced in small lots, and in-betweens - according to the difference in pattern of development among subsectors of the bicycle parts industry: (1) the group of capital-intensive items which can be mass-produced in big mechanized factories, such as rims, chain, spokes, and free wheel; (2) that of labour-intensive items whose production processes can be infinitesimally fractionized, many of the fractions being accomplished manually, and which are manufactured in a form of social division of labour among medium- and small-scale factories clustered into local blocks, such as frame, front forks, brakes, and bottom bracket and head parts; (3) that of items falling between the first two groups, such as chain wheel and cranks, hubs, pedals, mudguards, and bell. An article by Yoritada Mishina and Jun'ichi Yamamoto in Ōsaka Furitsu Shōkō Keizai Kenkyūjo, Jitensha Kōgyō no Teitaisei to Kōzōteki Henka: Kikai Kōgyō ni okeru Chūshō Kigyō no Saihen Katei [The stagnating trend of and structural changes in the bicycle industry: the reorganizing process of medium- and small-scale enterprises in the mechanical industry], Part 7, 1961, pp. 1-2. The book will hereinafter be referred to as Structural Changes. While the classifications from the mechanical engineering point of view under a and b hardly change over time, the classification under c by the stage of technological development in the industry can change with the advance of technology, and from a similar standpoint the author would tentatively suggest the following classification as well to reflect the current state of the industry: (1) the group of capital-intensive items, which are limited in variety and can be mass-produced in automated processes, such as the rims, chain, and spokes; (2) that of more skill-intensive items, mainly

involving metal machining and joining, such as the frame, front forks, handlebars, rim brakes, gear case, luggage carriers, stand, and saddle; (3) that of technology-intensive items, mainly those used in the driving mechanism, involving sophisticated machining and assembling procedures, such as the transmission, free wheel, chain wheel and cranks, hubs, pedals, calliper brake, and hub brake.

12. The output in 1937, combining both finished bicycles and parts, was equivalent to 2.26 million finished vehicles, out of which 1.14 million-unit equivalents or about 50 per cent were exported. Sakai-shi Keizai-bu Shōkō-ka, Sakai no Dentō Sangyō (Traditional industries of Sakai), March 1972, p. 32.

13. According to the customs clearance statistics of the Ministry of Finance, the combined value of Japan's machinery exports in 1937 stood at ¥180,470,000, in which the greatest share — ¥29,210,000 or 16.2 per cent — was held by bicycles, parts, and accessories, followed by marine boilers (14.8 per cent), rolling stock, parts, and accessories (11.5 per cent), and automobiles, parts, and accessories (11.4 per cent). A Century, p. 329.

14. Table 4 indicates a transient increase in exports in 1950 and 1951 that owed much to the resumption of trade with China in 1950. As dollar-based Chinese assets deposited with the Japanese branches of American banks were not frozen then, they were used to finance exports of 5,000 bicycles in 1950 and 80,000 in 1951, together with parts, totalling $3 million. In those days, there were no diplomatic relations between Japan and China, and the international political situation prevented normalization of trade between them. There also were many other obstacles to commerce between the two nations, including the difficult choice of commodities to be bartered and the unsmooth settlement of accounts; as a result bicycle exports to China sharply declined from 1952 on. A Century, p. 432.

15. Toshio Shibata, "Higashi Ajia Chūshinkoku no Yushutsu Shinchō to Wagakuni Chūshō Kigyō, Case Study 4, Jitensha Dōbuhin," in Nihon Bōeki Shinkōkan (JETRO), Kaigai Shijō [Overseas markets], XXVIII, 322, August 1978, p. 50. The book will hereinafter be referred to as Case Study.

16. See Table 3.

17. In 1976, the US was the leading importer of bicycles and their parts, totalling $150 million, followed by West Germany ($67 million) and the Netherlands ($55 million). Jitensha Sangyō Shinkō Kyōkai, Jitensha Tōkei Yōran [Handbook of bicycle statistics], 13th ed., 1979, p. 229.

18. Case Study, p. 51.

19. Summarized from ibid., pp. 51-54.

20. Ibid., p. 54.

21. According to Tsūshō-sangyō-shō (Ministry of International Trade and Industry), ed., Zenkoku Kikai Kōjō Meibo [National directory of machinery factories], 1977 ed., in Saitama Prefecture there is a total of nine factories, including both those for finished bicycles and those for parts, of which three belong to major manufacturers headquartered in Tokyo and which, combined, account for most of the aggregate shipments from all the bicycle factories in the prefecture. Therefore most of the value statistically listed as shipments from Saitama factories is attributable to Tokyo-based manufacturers.

22. It is not only in Japan that the bicycle industry started with parts production. When Britain, then the king of the bicycle-manufacturing world, stopped her export during World War I, all other advanced nations began copying British-made bicycle components to maintain the supply of replacement parts. Here lies both the reason for the international unification of standards for bicycle parts and the background of activated international exchange in them. Case Study, p. 56.

23. Ōsaka Furitsu Shōkō Keizai Kenkyūjo, Ōsaka ni okeru Jitensha Sangyō no Jittai: Seisan-hen [Actual situation of the bicycle industry in Osaka: volume on production], 1954, p. 21. The book will hereinafter be referred to as Situation. Its contents are the findings of joint research by Yoritada Mishima, Jun'ichi Yamamoto, Shō Taniguchi, Yoshio Morikawa, and the present author.

24, 25. Problems, p. 57.

26. For instance, Araya Kōgyō specializes in rims, Sugino Tekkō in chain wheels and cranks, and Shimano Kōgyō together with Maeda Kōgyō in transmissions and free wheels. Ibid., p. 57.

27. Structural Changes, p. 2.

28. For example, Shimano Kōgyō, a major bicycle-parts manufacturer (whose stock is listed on the first section of the Stock Exchange), is referred to in Tōyō Keizai Shimpō-sha, Kaisha Shikihō [Quarterly report on companies], 1979, No.3, p. 587, as "an integrated manufacturer of bicycle components for driving and braking mechanisms, holding an overwhelming share in the world market."

29. Problems, p. 57.

30. Ōsaka-fu Shōkō-bu, Ōsaka-fu Jitensha mata wa Sono Bubunhin no Seizōgyō Sanchi Chūshō Kigyō Shinkō Vijion [Vision of promotion of smaller enterprises in production centres of bicycles or their parts in Osaka Prefecture], 1979, p. 2. The book will hereinafter be referred to as Promotional Vision.

31. An article by Ryōji Takada in Ōsaka-furitsu Shōkō Keizai Kenkyūjo, Saikin 10-nenkan ni okeru Ōsaka Chūshō Kōgyō no Kihon Dōkō: Sono 11, Jitensha Seizōgyō [Basic trends of smaller industries in Osaka during the last 10 years: part 11, bicycle industry], 1969, p. 15, The book will hereinafter be referred to as Basic Trends.

32. A company holding a large share in the market supplies a wide variety of rims ranging in quality from those for "bargain sale" bicycles to those for established brands and highest-class stainless-steel products. Ōsaka-fu Shōkō-bu and Momoyama Gakuin Daigaku Sōgō Kenkyūjo, Jiba Sangyō Gijutsu Jittai Chōsa Hōkōkusho [Report of a survey on the actual technological situations of endogenous local industries], chapter 5 on bicycle-parts manufacturers (written by Kunio Gōtō), 1978, p. 61. The book will hereinafter be referred to as Technological Survey. It is based on joint research by eight co-workers, of whom one is the present author.

33. Problems, pp. 66-67.

34. The proportion of assemblies by retailers is falling off, as will be referred to in more detail in chapter III.4.

35. For further details on the marketing mechanism see Problems, pp. 66-68.

36. Nihon Keizai Shimbun-sha, ed., Nihon Sangyō Hyakunen-shi (A hundred-year history of the Japanese industry), volume II, quoted in A Century, pp. 35-36.

37. A Century, p. 369.

38. Ibid., pp. 373, 376.

39. Ibid., p. 376.

40. Ibid., pp. 382-383.

41, 42. Ibid., p. 383.

43, 44, 45. A Century, p. 363.

46. Situation, p. 23.

47. A Century, p. 39.

48. Ibid., p. 364.

49. Seiji Keizai Kenkyūjo, "Jitensha Kōgyō no Kōzō to Kiki no Shozai" [Structure of and factors critical to the bicycle industry] in Seikei Gesshi [Political economy monthly], no.10, December 1962.

50. The only remaining bicycle manufacturer among the converted makers is Katakura Jitensha K.K. If one also counts postwar participants affiliated with major manufacturers in non-bicycle areas, the only surviving one is Bridgestone Cycle K.K., which started production of finished bicycles in 1949. A Century, p. 365.

51. The law was amended in 1957 to expand the object of the promotional subsidy from the bicycle sector alone to the mechanical industry in general, with the quoted passage being rewritten as follows: "to

contribute to improving and promoting the export of bicycles and other machinery and to rationalization of the mechanical industry. . . ." A Century, p. 409.

52. Ibid., p. 43.

53. Ibid., pp. 411-412.

54. Ibid., p. 412.

55. Ibid., pp. 414-415.

56. The duties of the research foundation and guidance service stations were:

    (1) Research on materials and techniques for the production of bicycles

    (2) Research on designs of bicycles

    (3) Research on production control and equipment rationalization in bicycle factories

    (4) Technical consultation, surveys, tests, research projects, designing, and test production at the request of bicycle manufacturers

    (5) Training and re-education of bicycle technicians

    (6) Acquisition and administration of industrial property concerning bicycles

    (7) Publication and dissemination of, and guidance concerning, the fruits of the foregoing activities through official organs and seminars

    Ibid., pp. 453-454.

57. Ibid., p. 422.

58. Technological Survey, p. 65.

59. For instance, the part of the bracket axle that is to fit into the crank hole is supposed to measure 5/8 inch in diameter by the British Standard, and the corresponding Japanese standard is 15.88 mm, the metric equivalent of 5/8 inch. Jitensha Sangyō Shinkō Kyōkai, Jitensha Jitsuyō Binran [Practical handbook of bicycles], 3rd ed., August 1977, pp. 17-18.

60. "Jitensha Ryaku-nempu" (Brief chronology of bicycles) in A Century, pp. 512-514.

61. Ibid., p. 436.

62. Ibid., pp. 436, 438.

63. Ibid., p. 437.

64. Ibid., pp. 437-438.

65. Ibid., p. 439.

66. Structural Changes, pp. 7-8.

67. Ibid., p. 8.

68. A Century, p. 439. The aforementioned Bicycle Technology Research Foundation seems to have played an important role in the development of packaging-assembly techniques.

69. Ibid., p. 440.

70. Basic Trends, p. 111.

71. Ibid., pp. 108-109.

72. Tsūsan-shō Kōgyō Gijutsu-chō (Industrial Technology Agency, MITI), Wagakuni Kōgyō Gijutsu no Jittai [Situation of industrial technology in Japan], 1949. Quoted in Situation, p. 45.

73. A Century, pp. 43-44.

74. See chapter III.4.

75. Basic Trends, pp. 66-70.

76. Shimano Kōgyō K.K. in Sakai City, Osaka. According to Shimano Kōgyō 50-nen no Ayumi (50-Year history of Shimano Kōgyō), in or about 1957 the cold-forging technique became known in Japan when a German machinery manufacturer at a Japanese trade fair exhibited a cold-forging machine, which attracted much interest. Shimano immediately launched its own research on this new technique. As its export of three-speed hubs to the US started on a regular basis, necessitating their mass-production, Shimano accelerated its R & D efforts in 1960 and succeeded in 1962 in industrial application of its cold-forging technique to the production processes of three-speed hubs, ordinary hubs, and free wheels. The newly developed method afforded smaller, lighter, yet stronger products of uniform quality. It also resulted in a 36 per cent saving in material consumption, as only 400 grams of the material were sufficient for cold forging where 685 grams were required by hot forging. Moreover, little if any machining was needed after forging to obtain finished products. The machining cost of three-speed hub parts and free-wheel parts, for instance, was reduced by 25 to 35 per cent on an average as a result of either totally dispensing with or shortening some parts of the process. Had the development of the cold-forging technique been delayed by years, the manufacturer would have been unable to start mass-production of three-speed hubs in time for it to avail itself of marketing opportunities in the US. By that time, fortunately, financial institutions' evaluation of bicycle-parts manufacturers had considerably improved in part because of the active demand for three-speed hubs, and collateral funds had also become

available from the Bicycle Industry Association and others (loans deriving from the aforementioned subsidy for promotion of the bicycle industry). Stimulated by the improved financial situation, capital investments were made year after year from 1960 on. Shimano Kōgyō 50-nen no Ayumi, published by Diamond-sha in 1971, pp. 99-111.

77. Promotional Vision, p. 15.

78. During the four-year period from 1964 through 1967, some ¥2,400 million was invested in machines specified under the Law for Promotion of Modernization. Basic Trends, p. 71.

79. Shimano Kōgyō 50-nen no Ayumi, pp. 111-113.

80. An article by Kunio Goto in Technological Survey, 1978, pp. 59-68.