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**THE DEVELOPMENT OF THE
EYEGLOSS INDUSTRY IN JAPAN**

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This paper is being circulated in a pre-publication form to elicit comments from readers and generate dialogue on the subject at this stage of the research.

I. BRIEF DESCRIPTION OF SUNDRY GOODS INDUSTRIES

The field of research of this subproject is that of smaller companies as opposed to big business, and the industry which is to be dealt with in the present paper is the eyeglass lens industry, generally classified in Japan as one of the "sundry goods" industries.

Like the textile industry, Japanese sundry goods industries have since the Meiji Period supplied many of the final consumer products that are such an integral part of everyday life in this country and contributed to the development of the Japanese economy as an export industry as well.

Although sundry goods industries are not precisely defined, the following can be cited as some of their characteristic features:

- 1) They all produce final consumer products.
- 2) They are all light manufacturing industries.
- 3) Demand for their products is in small lots.
- 4) The companies in them are smaller companies.
- 5) They are labor-intensive.
- 6) They export a high percentage of their production.
- 7) The companies in them are organized into groups.

Although these characteristics have been listed separately, they are by no means independent of one another. Demand in small lots has meant that they produce small quantities of many different products,

and this has been a constraint on mechanization as well as the reason why they have depended on manual manufacturing techniques. These circumstances in turn have discouraged the entry of large companies. Furthermore, lower wages than in other industries have made such dependence on manual manufacturing techniques still greater, as have the mobilization of family labor and the farming out of piecework to people working in their own homes, and this has been the basis on which such industries have been internationally competitive and able to make inroads into foreign markets.

Many of the manufacturing industries in the Japan Standard Industrial Classification, other than all food and textile industries and most chemical, metallurgical, and machinery industries, fall under the category of sundry goods industries. Of the 559 manufacturing industries in the detailed classification (two tobacco-related industries excluded), 81 can be considered to belong to this category (see the list below).

Most of these sundry goods industries were transplanted from abroad after the Meiji Restoration. Unlike the traditional local industries that had developed during the Tokugawa Period, they were mainly located at first in the vicinity of large cities where there was considerable consumer demand for their products. In other words, they were urban industries developed with a view to exporting to foreign markets that were also well situated from the standpoint of availability of raw materials, marketing, and development of related industries. Some of them developed in an outward direction, from cities to areas

around them and on to rural communities further out, and many of them, after becoming firmly established, were able to develop still further thanks to the advantages of concentration, coming not only to meet local demand but also to acquire nationwide and even foreign markets.

The many different kinds of sundry goods industries and different varieties of the same kind each developed according to their own characteristics and circumstances, which makes it difficult to lump them together as a general category. Nevertheless, an attempt should be made to describe in general terms the circumstances that they have more or less had in common in fairly recent years as a context for study of "the Japanese experience" in specific industries in this category.

The first circumstance that should be noted in this respect is the decline of sundry goods industries after about 1955 as the structure of Japanese industry and that of Japanese imports shifted toward chemical and other heavy industries and the rise of sundry goods industries in developing countries as serious competitors after about 1965. This competition, which was easily forthcoming in this labor-intensive and technologically unsophisticated area, dealt a serious blow to the exports of some of these Japanese sundry goods industries, and not only were they forced to reorient themselves completely or partly to domestic markets, but they have even suffered serious setbacks at home in the face of imports from such competing industries in developing countries.

Secondly, although sundry goods industries as a whole experienced

an increase in demand along with rapid growth of the Japanese economy, they had to face such problems as labor shortages, rising wages, soaring raw material costs, rising imports, and the need to raise the level of their technology, and many that had been highly dependent on exports found it necessary to shift to emphasis on domestic markets. Furthermore, after 1974 economic growth slackened its pace, and this resulted in increasing idleness of production facilities, stiffer marketing competition, the entry of large firms into sundry goods industries with growing demand, and an increase in sundry goods imports from advanced countries as well as the value of the yen rose. There was a widening gap between firms with good product development and sales capabilities and firms without them, and some of the latter had to switch to other industries or even fold altogether, and this has resulted in change in the structures of the industries in question.

Thirdly, there has been change with respect to locational conditions in large cities. Many of the firms in sundry goods industries in and around cities are now located in mixed residential and industrial areas, resulting in an increase in such external diseconomies as scarcity of suitable sites, pollution, and traffic congestion, and because of this, competition between different domestic production areas has become stiffer in some cases.

Fourthly, under present recession conditions resulting from slower economic growth, firms in sundry goods industries, which are in almost all cases small firms, are still finding it very difficult to

employ younger workers, and furthermore, in spite of rising costs because of labor-intensiveness and rising wages, they are having more and more difficulty in trying to raise their product prices to absorb such additional costs in view of the stiff competition.

List of Sundry Goods Industries (from detailed classification of manufacturing industries)

- 2 2 Lumber and wooden product manufacturing industries
 - 2214 Thin wood sheets for wrapping and products made from it
(excluding small wooden boxes and match boxes)
 - 2215 Excelsior
 - 2231 Bamboo, rattan, wicker, and other containers
 - 2232 Small wooden boxes
 - 2234 Japanese casks
 - 2235 Western-type casks
 - 2236 Tubs
 - 2241 Wooden footwear
 - 2243 Wooden rings and circular wooden boxes
 - 2249 Wooden products not classified elsewhere (including bamboo and rattan products)
- 2 3 Furniture and fixture manufacturing industries
 - 2311 Furniture (excluding metal and lacquer ware)
 - 2321 Religious goods and implements
 - 2392 Window and door blinds and awnings
 - 2393 Japanese folding screens, clothes racks, and rattan blinds
 - 2394 Mirror and picture frames

- 2 4 Pulp, paper, and paper processed goods manufacturing industries
 - 2441 Office paper products
 - 2442 School paper products
 - 2443 Everyday paper products
 - 2449 Other paper products
 - 2453 Paper containers
 - 2499 Pulp and paper processed goods not classified elsewhere
- 2 6 Chemical industries
 - 2652 Soap and synthetic detergents
 - 2657 Candles
 - 2695 Cosmetics, toothpastes, and other toiletries
- 2 8 Rubber product manufacturing industries
 - 2821 Rubber footwear and accessories
 - 2822 Plastic footwear and accessories
 - 2899 Other rubber products not classified elsewhere
- 2 9 Tanned leather, tanned leather products, and fur product manufacturing industries
 - 2941 Leather footwear
 - 2951 Leather gloves
 - 2961 Satchels, briefcases, suitcases, etc.
 - 2971 Bags
 - 2991 Saddlery and whips
 - 2999 Tanned leather products not classified elsewhere
- 3 0 Ceramic, earthen and stoneware manufacturing industries
 - 3014 Glass containers
 - 3016 Table and kitchen glass utensils

- 3019 Other glass products
- 3042 Table and kitchen ceramic ware
- 3043 Ceramic ornaments
- 3092 Cloisonné ware
- 3093 Artificial jewelry
- 3 3 Metal product manufacturing industries
 - 3321 Tableware
 - 3323 Meters and gauges, craft tools, hand tools (excepting rasps, saws, and table cutlery)
 - 3329 Other hardware
- 3 7 Precision machinery and tool manufacturing industries
 - 3761 Eyeglasses
- 3 9 Other manufacturing industries
 - 3911 Precious metal products
 - 3912 Jewelry accessories, material processing, and jewelry ware
 - 3921 Pianos
 - 3922 Organs
 - 3923 Guitars
 - 3924 Phonograph records
 - 3929 Other musical instruments and musical instrument parts and materials
 - 3931 Entertainment articles and toys (excepting dolls and play vehicles)
 - 3932 Dolls
 - 3933 Play vehicles
 - 3934 Sports goods

- 3941 Fountain pens, sharp pencils, and pen points
- 3942 Ball point pens and marking pens
- 3943 Pencils
- 3944 Writing brushes and painting paper (excluding pencil sketching paper)
- 3949 Office goods not classified elsewhere
- 3951 Personal and decorative ornaments (excluding jewelry and precious metals)
- 3952 Artificial flowers and decorative plumage
- 3953 Buttons
- 3954 Needles, pins, hooks, snaps and related products
- 3969 Other plastic products not listed elsewhere
- 3971 Lacquer ware
- 3981 Straw and Panama hats
- 3982 Tatami
- 3983 Straw products (other than tatami and hats)
- 3984 Brooms and brushes
- 3985 Cork processed basic materials and cork products
- 3986 Matches
- 3987 Fireworks
- 3988 Signs and signals
- 3989 Wigs
- 3991 Western umbrellas and parts
- 3992 Japanese umbrellas and parts
- 3993 Hand fans and paper lanterns
- 3994 Models (excluding those made of paper)

3995 Thermos flasks and jugs

3999 Other manufacturing industries not classified elsewhere

II. THE EYEGLOSS INDUSTRY AS A FOREIGN TRANSPLANT

Eyeglasses first came to Japan as early as 1530, but it was not until the Meiji Period that the eyeglass industry began to develop as a modern industry in this country. As a foreign transplant, the Japanese eyeglass industry developed in its own way in accordance with conditions in this country after getting started with technology imported from advanced countries.

Consisting of groups of smaller export-oriented firms in particular areas, the Japanese eyeglass industry can be said to be a very typical sundry goods industry in that it has developed with most of the characteristics of such industries mentioned above and has also faced all of the problems resulting from change in the business environment as also described in the above.

Just how has the industry changed during its development after starting out as a foreign transplant, and how is it coping with the problems that it faces today? The eyeglass industry can serve as a very good model case in trying to describe "the Japanese experience" in terms of specific sundry goods industries.

III. PRESENT STATE OF THE EYEGLASS INDUSTRY, WITH EMPHASIS ON OSAKA

(1) Production Areas - Groups of Smaller Firms in Particular Areas

The main production areas of the eyeglass industry in Japan are Tokyo, Osaka, and Fukui, the first two concentrating mainly on lenses and Fukui specializing chiefly in frames. In all three areas the firms in the industry, for the most part smaller firms, have associated together into groups in the course of their development.

Table 1 gives production figures for these areas in past years as well as indicating how the percentages that they have represented of total national production have changed over the years. Between 1965 and 1975 production in the Tokyo and Fukui areas increased far more than in the Osaka area, with the result that their shares of the national total rose from 27.2% to 29.7% (Tokyo) and 35.5% to 40.2% (Fukui) whereas that of Osaka declined from 24.1% to 11.5%.

The same trend is to be seen no matter what production figures are taken - those for the whole finished product, those for frames alone, or those for lenses alone. The highest rates of increase have been for the whole finished product (probably mostly sunglasses) and frames in the Fukui area and lenses in the Tokyo area. Osaka, however, which has always specialized mainly in lenses, which now account for 55% of total national production in all three categories taken together, has seen its share of national lens production decline from 31.4% in 1965 to 18.5% in 1970 and 12.3% in 1975, whereas Tokyo has come to represent

52.0% and new lens production areas have developed substantially in recent years in Kochi and Nagano prefectures.

(2) Supply and Demand - Decline in Exports and Rise in Imports

Although the situation differs somewhat between the long term and the short term in Japanese eyeglass exports, in recent years quantities have been trending down as the eyeglass industries of developing countries have come into their own. Lens exports peaked at 1,890,000 dozen in 1974 and then declined 12% to 1,547,000 dozen in 1975 (still 43% increase over 1970); base metal frame exports also declined from 263,000 kg in 1973 to 200,000 kg in 1975 (down 24% but still 6.7 times the figure for 1970); and complete glasses exports likewise dropped 30% from 3,089,000 dozen in 1970 to 2,162,000 dozen in 1975. The monetary value of such exports, however, has been rising, partly owing to more emphasis on higher quality products and partly owing to inflation, the figures for overall production worth being ¥7,915 million in 1970 and ¥14,953 million in 1975, for an 89% increase over the five-year period (see Table 2).

As for imports, there is an upward trend in both quantities and monetary worth of imports of mainly high-class frames from West Germany, France, and the U.S. In 1975 the figures for quantities were down slightly from the year before because of the recession, but total worth increased further to ¥12,517 million, or 4.3 times the figure for 1970 of ¥2,918 million (see Table 3).

TABLE 1. Eyeglass Production and Percentage Breakdown by Area

		1965		1970		1975		Number of Production Establish- ments
		Million Yen	%	Million Yen	%	Million Yen	%	
Total Production	Nationwide	8,273	100	27,653	100	73,572	100	...
	Osaka	1,997	24.1	4,409	15.9	8,452	11.5	...
	Tokyo	2,251	27.2	7,055	25.5	21,986	29.7	...
	Fukui	2,935	35.5	11,737	42.4	29,542	40.2	...
Complete Eyeglasses	Nationwide	770	100	2,785	100	9,285	100	93
	Osaka	516	67.0	1,408	47.2	3,329	35.9	22
	Tokyo	112	14.5	122	4.1	121	1.3	6
	Fukui	87	11.3	1,436	48.1	5,104	55.0	60
Frames	Nationwide	3,938	100	12,095	100	28,504	100	529
	Osaka	364	9.2	677	5.6	713	2.5	28
	Tokyo	290	7.4	634	5.2	3,242	11.4	42
	Fukui	2,821	71.6	9,881	81.7	23,320	81.8	428
Lenses	Nationwide	3,565	100	12,574	100	35,783	100	256
	Osaka	1,118	31.4	2,324	18.5	4,409	12.3	160
	Tokyo	1,849	51.9	6,299	50.1	18,623	52.0	29
	Fukui	25	0.7	421	3.3	1,119	3.1	15

Note: Besides the figures given for lens production in 1975, Aichi Prefecture produced ¥4,785 million worth (13.4% of national total) and Nagano Prefecture ¥845 million worth (4.9% of national total).

Source: Ministry of International Trade and Industry, "Itemized Industrial Statistics Tables".

TABLE 2. Japanese Eyeglass Exports over the Years (Worth in Millions of Yen)

Year	Glass Lenses for 861-112 Eyeglasses		Frames, Bows, & Parts for 861-211-219 Eyeglasses					
	Amount	Worth	Base Metals		Celluloid		Artificial Plastic	
			Amount	Worth	Amount	Worth	Amount	Worth
	1,000 dozen		kg		kg		kg	
1970	1,080	953	30,005	239	24,941	242	29,990	239
1971	1,460	1,299	74,693	861	13,424	137	31,333	346
1972	1,525	1,517	135,175	1,874	3,185	37	30,862	315
1973	1,711	1,858	263,367	4,113	3,228	32	20,482	230
1974	1,890	2,114	214,376	4,154	2,931	30	26,529	317
1975	1,547	2,341	199,772	3,756	1,861	28	24,567	384

	Other Eyeglass Products		861-220 Eyeglasses		Total Worth
	Amount	Worth	Amount	Worth	
	kg		1000 dozen		
1970	12,202	129	3,089	6,113	7,915
1971	11,195	127	2,550	5,395	8,165
1972	10,776	110	2,571	5,631	9,484
1973	10,080	133	2,165	4,606	10,972
1974	10,874	209	1,959	5,871	12,695
1975	7,510	165	2,162	8,279	14,953

Source: "Monthly Japanese Trade Tables".

TABLE 3. Japanese Eyeglass Imports over the Years (Worth in Millions of Yen)

Year	Glass Lenses for Eyeglasses (Optically Ground and Polished, without Frames or Bows Attached)		Frames, Bows, and Parts (Precious Metals, or Coating or Thereof, or Tortoise Shell)		Frames (Other than Metal, or Celluloid, or Synthetic Resin)		Frames, Bows, and Parts (Other than Preceding Types)		Complete Eyeglasses (Precious Metals, or Coating or Thereof, or Tortoise Shell)		Complete Eyeglasses (Other than Preceding Types)		Totals
	Amount	Worth	Amount	Worth	Amount	Worth	Amount	Worth	Amount	Worth	Amount	Worth	
	dozen	kg	kg	dozen	kg	kg	kg	dozen	dozen	dozen	dozen	dozen	Worth
1970	173,426	784.5	18,696	1,095.5	417	14.1	12,697	486.2	5,819	76.2	68,562	461.1	2,917.6
1971	115,393	602.4	26,378	1,537.8	715	21.0	13,634	581.0	6,838	121.9	73,835	503.7	3,367.8
1972	149,708	747.4	34,220	2,212.2	924	40.2	18,130	609.3	9,858	123.1	94,613	628.5	4,360.7
1973	276,370	997.9	48,695	4,182.0	1,472	63.9	36,752	1,599.5	60,317	253.0	137,229	872.2	7,918.5
1974	379,964	1,583.7	51,217	5,305.0	1,406	52.7	37,031	1,584.1	62,796	452.2	217,063	1,651.6	10,629.3
1975	348,307	1,770.5	46,272	6,114.8	882	44.5	34,033	2,093.2	75,084	826.0	134,586	1,667.7	12,516.7
Imported	1970	U.S.	W. Germany	France	France	W. Germany	W. Germany	France	France	W. Germany	France	Italy	
Mainly		W. Germany	France	W. Germany	W. Germany	W. Germany	W. Germany	W. Germany	W. Germany	Netherlands	U.S.	W. Germany	
From	1975	U.S.	W. Germany	Hong Kong	W. Germany	W. Germany	W. Germany	U.S.	U.S.	S. Korea	France	W. Germany	
		W. Germany	France	Austria	Austria	Austria	Austria	S. Korea	W. Germany	W. Germany	W. Germany	Austria	
		Thailand		Spain									
		France											

Source: "Monthly Japanese Trade Tables".

Notes: 1. The item numbers are 861-111, 861-211, 861-218, 861-219, 861-221, 861-229.

2. Countries "mainly imported from" are those with at least a 10% share of the total worth of such imports.

From these three tables one sees that in 1975 Japan produced ¥73,572 million worth of eyeglass products, exported ¥14,953 million worth, and imported ¥12,518 million worth, for a net domestic supply of ¥71,137 million worth, exports equivalent to 20.3% of production, and imports equivalent to 17.6% of domestic demand. Over the long run exports are declining percentage-wise, and imports increasing.

(3) Size of Firms in Industry - Mostly Small Firms

In Osaka eyeglass manufacturing firms form local production area groups in and around Ikuno Ward, centering on Tajima-cho, and in Kishiwada City, centering on Shimomatsu-cho. In Osaka Prefecture there are four business cooperatives, one industrial cooperative, and several informal associations in the eyeglass industry. As of the end of November 1976, the total membership of these four business cooperatives was 223 firms, or 218 if those with membership in more than one are not counted more than once. In addition, there are about 80 nonmember firms in and around Tajima-cho, and approximately 50 in the Kishiwada area, for an overall total of about 350 eyeglass manufacturing firms in the Osaka area.

Most of the member firms are small - 78.7% with 6-20 employees and 13.6% with 5 or fewer employees, or 92.3% with 20 or fewer employees. Most of the nonmember firms have no more than 5 employees, and only one firm has more than 100 (130-odd). (See Table 4.)

It is estimated that about 130 of the members manufacture lenses, 74 manufacture sunglasses and frames, and 8 manufacture magnifying glasses.

The Fukui eyeglass manufacturing area, centring on Sabae City, has mainly specialized in frames and is purported to consist of a total of about 1,200 firms, including small subcontractors, approximately 300 of these firms being all-round eyeglass manufacturers and about 280 belonging to the Fukui Prefecture eyeglass industrial cooperative.

TABLE 4. Breakdown of Number of Eyeglass Manufacturers by Size (Number of Employees)

Number of Employees	Osaka*		Number of Employees	Fukui**	
	Number of Firms	%		Number of Firms	%
Total	221	100	Total	280	100
5 or fewer	30	13.6	5 or fewer	143	51.1
6- 20	174	78.7	6-29	85	30.4
21- 50	12	5.4	30-49	30	10.7
51-100	4	1.8	50-99	15	5.4
101 or more	1	0.5	100 or more	7	2.5

* Source: Survey by Japan Export Eyeglasses Industrial Cooperative.

- Notes: 1. Figures cover only members of the four business cooperatives.
 2. Additionally, there are about 130 nonmembers, none of which have more than 5 employees.

** Source: Fukui Prefecture Eyeglass Industrial Cooperative.

- Notes: 1. Figures cover only members of this cooperative (as of end of November 1976).
 2. In addition there are reported to be about 900 very small contractors.

Seven of the members of this cooperative have 100 employees or more, the largest number being 200, and 52, or 19%, have at least 30 employees. One sees, therefore, that eyeglass manufacturers that are cooperative members tend to be larger in the Fukui area than in the Osaka area. (See Table 4.)

(4) Production - Outside Orders and Subcontracting

One characteristic of production in the eyeglass industry is product differentiation by area. Most of the manufacturers in the Tajima area of Osaka specialize in grinding and polishing of myopic and hyperopic lenses or in sunglasses, most of those in Kishiwada City in grinding and polishing of astigmatic, myopic, hyperopic, and double-focus lenses, and most of those in the Tatsumi area of Ikuno Ward in sunglasses.

The tendency is for small firms of the cottage industry type with no more than 5 employees to produce only a single type of product and for the number of different types of products to increase along with the number of employees. For instance, the largest firms, those with a hundred or more employees, manufacture nine different product types - shade lenses, plastic lenses, plastic frames, celluloid frames, complete eyeglasses, sunglasses, glass sunglass lenses, plastic sunglass lenses, and goggles - and those with 40-49 employees manufacture four different product types - double-focus lenses, polarized lenses, plastic lenses, and plastic sunglasses.

These larger firms do not actually manufacture all of these items on their own premises. Rather, they do a considerable amount of placing of outside orders and subcontracting, some of them relying to a high degree on ordering of both finished products and partial processing. Most of the firms with 5 or fewer employees are subcontractors to other larger eyeglass manufacturers, and most of those with 6 or more employees rely at least to some extent on outside ordering and subcontracting.

Besides furnishing subcontractors with materials and having them manufacture the finished product completely, many firms have their subcontractors do partial processing such as lens grinding and polishing, finishing, and reinforcement coating. If both kinds of subcontracting and outside ordering are included, the average number of small firms doing such work for a single manufacturer is 4-5 in the case of lens manufacturing and about 7 in the case of completed sunglasses, but there are some manufacturers that have as many as four such subcontractors or order-taking firms.

This production scheme in which there is heavy reliance on outside orders and subcontracting is commendable from the standpoint of making it possible to overcome the many disadvantages of manufacturing a large number of products in small quantities by means of division of labor and from the standpoint of having a cushion against fluctuation in market conditions and being able to get by with low labor costs on the basis primarily of specialized family labor, but it is also a fact that it has stood in the way of modernization of operations, including improvement of the level of technology.

This production scheme can also be partly explained by the fact that the marketing side of the business has a great advantage in transactions over the manufacturing side, a full 55% of the manufacturers selling over 50% of their production to a single buyer and only 19% of them selling less than 30% of their production to any single buyer. Needless to say, the smaller the firm, the stronger this tendency is in view of the fact that smaller firms manufacture fewer types of products. Particularly in the case of domestic transactions the production side is in a weak position in all respects, including payment terms, unit prices, size of orders, and claims.

Besides eyeglass manufacturers themselves, the industry also consists of a wide range of related types of firms, including lens materials (lens blanks, plate glass, blown glass) and polishing materials, manufacturers and cutters, heat treaters, reinforcers, manufacturers of frame screws, coaters, painters, and machinery manufacturers.

(5) Marketing

From the figures we have just seen on the percentages that eyeglass products manufactured in the Osaka area represent the national totals, one can assume that in many cases Fukui frames and Osaka lenses go together to make complete eyeglasses. Considering the fact, however, that Osaka's share of the national total of such production has been declining, it is clear that the place where they

come together is more often than not Fukui. In other words, Osaka lenses, and particularly those for sunglasses, are shipped to Fukui for the manufacture of complete eyeglasses.

Also worthy of notice is the fact that frame production has become so important in the Fukui area that Osaka is coming to depend on it for supply of parts for its metal frames.

(a) Overseas Markets

As we have already seen in Tables 1 and 2, 20.3% of national eyeglass product production was exported in 1975. In the case of Osaka alone the percentage of exports appears to be even higher, and considerably so at that. In fact export inspectors estimate that approximately 85% of Osaka's eyeglass product production is exported, if one includes the frames that are shipped to Fukui and later exported as complete eyeglasses from there.

This kind of roundabout exporting accounts for a considerable portion of the exports of the Tajima area of Osaka's Ikuno Ward. Only about 50% of the production of the Kishiwada area is exported, however, owing partly to the fact that a high percentage of the production there is in high-class corrective lenses. According to statistics of the Japan Eyeglass Promotion and Optical Instruments Inspection Association, in 1975 61% of the goods inspected at the Osaka inspection facility (80% manufactured in Osaka Prefecture) were in the sunglass category,

18% in the two-side polished lens category, and 8% in the magnifying glass category.

Most of the exports in the eyeglass manufacturing industry are accounted for by the larger manufacturers, the export rate among them being particularly high, approximately 90%, for sunglasses and the worth of exports of complete sunglasses being much greater than that of exports of lenses. It follows, therefore, that the smaller firms, manufacturing mostly lenses, produce primarily for the home market.

Eighty percent of the export orders come from trading houses, and the other 20% from buyers, with over half of the exports going to the U.S. In recent years, however, Mexican, S. Korean, and Taiwanese products have been selling more on the U.S. market, with the result that the share of that market accounted for by Japanese sunglasses in the quality range of more than \$2.50 a dozen declined from 40% in 1970 to 26% in 1975, and European products are meeting much the same fate.

Nevertheless, because of a trend toward export of higher quality products with more value added, Japan's share of the market has not declined very much in monetary terms, and there was even some recovery in 1976. In the second half of the following year, however, Japanese eyeglass exports began to feel strongly the adverse effect of the rise in the value of the yen in terms of new orders.

The biggest problem facing the Osaka eyeglass manufacturing area

is the fact that its share of Japan's exports of eyeglass products as reflected in export inspection statistics declined from 63% in 1970 to 50% in 1975, which means that its exports are doing very badly. Greater emphasis on fashion, particularly in the case of sunglasses, has worked to the advantage of Fukui as a frame manufacturing area, and, besides that such new production areas as Aichi and Nagano are beginning to become very competitive in lenses. What this means is that the Osaka production area has been slower to adapt to changing conditions than other areas.

(b) The Home Market

As already mentioned, the smaller eyeglass manufacturers in the Osaka area are very much dependent on the home market, particularly in terms of lenses, but here, too, as in the case of the exports of larger firms, their share of the home market is declining in terms of quantity and even the monetary worth thereof is showing little growth.

The chief reason why only lenses are experiencing price stagnation while sunglasses and other eyeglass product sales are rising thanks to substantial price hikes is that large firms are coming into the home market. This explains the increase in the share of lens production in monetary terms represented by the Tokyo area that we have already noted. There are five large eyeglass manufacturing firms in the Tokyo area, including Hoya Glass and Nippon Kogaku, and the number one firm, with a production capacity that exceeds that of the whole Osaka area,

is eating away the market share of smaller firms with its well-known brand names, mass advertising, and formidable sales network.

If one were to ask the smaller firms in the Osaka area about the quality of the materials and products of such large firms, they would assert that there is no difference, but it is undeniably true that consumers place more confidence in name products because even if the actual production is done by a subcontractor, product quality is guaranteed by a system of strict inspection. Furthermore, the same kind of situation is beginning to develop in sunglasses, with smaller firms experiencing a decline in their market share in favor of such large manufacturers.

As for imports, high quality West German and French frames and sunglasses are making inroads into the Japanese market, but there is hardly any problem at all in this respect in terms of lenses. What is noteworthy in this regard, however, is that larger firms, in driving off potential lens imports, are, as a result, causing a decline in Osaka's share of the market since it is represented almost entirely by small manufacturers.

Competition from products of developing countries is being felt only in export markets since both product quality and marketing problems are working against their competitiveness on the Japanese market, and this situation should hold for the time being. The Japanese eyeglass industry is, however, keeping an eye on South Korean sunglass

manufacturers and Taiwanese metal frame and lens manufacturers that are becoming increasingly competitive and that might before long enter the Japanese market aided by bonded processing systems and other government support and taking advantage of the high yen exchange rate, particularly in view of the fact that there is some Japanese capital participation in these companies.

IV. HISTORY OF THE JAPANESE EYEGLASS INDUSTRY

(1) Pre-Meiji Period

The first reported appearance of eyeglasses in Japan is the presentation of a pair to Yoshitake Ohuchi by a Roman Catholic missionary sometime in the 1530's during the reign of Emperor Gonara, and the oldest ones still in existence are the two pair on display at Toshogu Temple that belonged to Ieyasu Tokugawa.

It was not until 1628, however, that the Japanese learned how to manufacture them when Yahee Hamada of Nagasaki passed on to a friend what he had been taught in this respect by a European. This manufacturing technique subsequently made its way from Nagasaki to Osaka and from there on to Kyoto and as far as Edo. It was hardly used, however, until the end of the Tokugawa Period because of the overwhelming advantage held by imported products. In those days the lenses made in Japan were mostly crystal, glass lenses being made only by processing "blue plate" glass imported from Holland.

It was not until after the Meiji Restoration that eyeglass manufacturing in Japan became an industry based on scientific technology.

(2) Background of Establishment of the Eyeglass Industry

In 1873 Matsugoro Asakura sailed to Europe to attend the

International Exposition in Vienna with the mission of learning what he could about the latest eyeglass manufacturing techniques, and the following year he returned to Japan with some eyeglass manufacturing equipment.

In those days the grinding and polishing of lenses in Tokyo, Osaka, Nagasaki, and elsewhere was done by hand, and it took 5-6 days to finish a single lens. Moreover, it was difficult to achieve exactly the desired lens strength.

With the equipment brought back by Asakura, though, it became possible for one man to complete 52 pairs of lenses in a single day and with uniformity of lens strength, which represented a revolution in terms of both quality and price. Unfortunately, however, this development came to nothing owing to the fact that Asakura passed away suddenly two years later while building a factory in which he was to put to use the equipment in question and accessory tools that he had borrowed from the government.

Let us take a look now at how the lens manufacturing in the Tajima area of Ikuno Ward, Osaka, got started.

In the Meiji Period the Tajima area was a pure rural village in the Settsu grain belt which also had long produced Kawachi cotton, grown on one-third of its cultivated acreage. In fact, there had already developed a considerable amount of cultivation of market crops

in many areas outside of Osaka. Unable to compete with imported foreign cotton, however, this local cotton began to be cultivated less about 1889, and by the end of the Meiji Period such cultivation disappeared entirely.

Earlier, at the end of the Tokugawa Period, there was a farmer in the Tajima area by the name of Tajiro Ishida. Not being able to engage in agriculture because of an injury to his right foot that he had suffered in his childhood, he began instead to manufacture eyeglasses locally after learning the necessary techniques. That was back in 1857, the date that marks the beginning of Tajima eyeglass manufacturing. In those days eyeglass manufacturing techniques were very primitive, with lenses being ground and polished one by one in the bottom of a pot. Furthermore, since there was not much demand for eyeglasses, there were still only two or three manufacturers as late as 1877.

Later on, however, with the waning of cotton cultivation, the Tajima area developed a labor surplus, and it just so happened that the eyeglass manufacturing industry was beginning to develop as demand at last began to grow and was therefore able to absorb this surplus labor as a means of increasing the scale of operations and bringing more cash income to the area. Thus, by the end of the Meiji Period there were already ten-odd well-known eyeglass factories in the area, some training their own workers and others hiring those who had already become skilled in eyeglass manufacturing techniques. Many of them, however, were only side businesses of independent or tenant farmers

that they ran at times of the year when agricultural work was slack, and even the more well-known ones were no more than cottage industries under the control of Osaka wholesalers. Since the manufacturing techniques employed in those days were still rather primitive, the market for higher quality products was monopolised by imports from Europe and particularly Germany.

As for the materials used, about 1877 the emery, colcothar, pitch, woollen cloth and some other necessary materials were produced at home, but the all-important glass was entirely imported as top-grade plate. This thick plate glass was too expensive to use directly, so lens makers were always looking for damaged plates that they could buy much cheaper. Eyeglass lens plate glass began to be imported in 1888, after which it was used exclusively in lens manufacturing, and it was not until the Taisho Period, which began in 1912, that such glass came to be manufactured regularly in Japan.

(3) Development of the Industry During and After the First World War

With the outbreak of the First World War, imports of eyeglass lenses and the glass for making such lenses were cut off, making it possible for Japan's own eyeglass lens manufacturers to achieve rapid development and begin to produce rather superior products in technological terms. Furthermore, around 1921 three lens glass manufacturing factories were set up in Tajima-cho.

In the meantime Osaka City was gradually expanding to the east, and Tajima, too, was incorporated into it in 1925. Having then lost all of its farmland, the Tajima area became increasingly one of people specializing in the manufacture of eyeglass lenses. By 1929 there were several hundred such manufacturers in and around Tajima, producing a total of 250,000 dozen lenses annually and even exporting some of this production to India and China.

With the introduction of electric motors in the 1920's, the traditional hand grinding gave way to grinding machines, which boosted production capacity enormously, and this resulted in a big increase in the percentage of production exported. In 1937 and 1938 60-70% of corrective lens production and more than half of sunglass production was exported to China, Southeast Asia, and the United States.

Thus, before the Second World War the Japanese eyeglass lens manufacturing industry enjoyed a period of unprecedented prosperity, but as the international situation grew tense around 1941, lens glass came into short supply, and after the outbreak of war in the Pacific and the cutting off of imports of good lens glass, this shortage became still more acute. There were plans to produce glass comparable to the German lens plate glass that had been imported up to then, but all sorts of constraints kept them from materialising. Since, however, demand for eyeglass lenses did not decline very much, the only recourse was to use ordinary thick plate glass. As the war situation worsened, many eyeglass manufacturers went off to war, and with such additional

difficulties as shortages of electricity and lens materials, many eyeglass factories had to close down. That is how things stood at the end of the war in August 1945.

The other centre of lens manufacturing in Osaka Prefecture, Kishiwada City, got started back when Yasutaro Morita settled down there after learning the necessary techniques of lens manufacturing from Kametaro Asakura, who carried on the enterprise his father was initiating in Tokyo at the time of his death at the end of the Meiji Period. Morita had 5-6 young apprentices from farm families in the Shimomatsu-cho area of Kishiwada, one of whom, Sotaro Iwabashi, set up his own lens factory in Shimomatsu-cho around 1921. Two or three years later this factory became bankrupt after the wholesaler that had been buying its lenses repeatedly returned inferior-quality lots, but it was soon taken over by the Isojiro Kai Store, an Osaka eyeglass processing business, and production was resumed, this time with twenty journeymen, including sons of farmers in the area. In 1931 however, the business failed again and for the same reason. Having lost their jobs, some of the journeymen went back to farming, but others remained in the eyeglass industry in Osaka and Nagoya. The Nakano brothers and a certain Nishita, both local men, started up a lens manufacturing business in Shimomatsu-cho again around 1935, and before the war the Shimomatsu area came to boast seven lens factories.

These were the histories of the formation of local groups of lens manufacturers in the Osaka area. In the Tajima area lens manufacturing

began in the Meiji Period as a part-time side business of farmers. Later it developed as very small rural enterprises on the outskirts of Osaka, and after the First World War it further developed into urban industries, although still small in scale, as the area became urbanized, largely on the basis of the cheap labour furnished by Korean workers, who were available in large numbers. In the Kishiwada area, on the other hand, lens manufacturing developed as family businesses at home that got started when farmers' sons learned the necessary techniques.

(4) Since World War II

Before the war, Japanese lens production reached its peak about 1937, when there were 170-180 manufacturers of corrective lenses in the Osaka area and about 40 in the Tokyo area and Japanese lens exports monopolized the East Asian market, totalling 1.3 million dozen, for a value of ¥3,240,000, in that year.

Although the corrective lens manufacturers in the Osaka area suffered little war damage and most of their equipment and facilities were still intact, until about the middle of 1947 they were not able to produce at more than about half of their prewar level because most of their factories had been shut down during the war. Domestic demand grew by the month, but exports had not even recovered to 40,000 dozen by 1948 because of the loss of the enormous market of the Chinese Mainland. Furthermore, up till about 1949 there was only enough imported lens plate glass to meet domestic demand, particularly in view of the shortage of electricity.

By 1950, however, the number of manufacturers reached its former level as demand increased in Southeast Asia, Africa, and the United States, and thereafter exports increased year by year, reaching 580,000 dozen in 1952, 860,000 dozen in 1953, and 1.4 million dozen in 1954, or more than the prewar peak. Exports continued to increase steadily in the following years, and the increase in demand attracted new entries into the industry. This resulted, however, in excessive competition, a fall in export unit prices, and a lowering of product quality. Although no other country yet presented itself as a serious competitor to Japanese lens exports, the downtrend in quality can be explained by the fact that it was necessary to "produce to the going price" as buyers in Southeast Asia and Africa, where demand was naturally for cheap lenses, beat down prices still further whenever transactions became regular.

In order to cope with this situation, the Japan Association of Eyeglass Product Exporting Industries was organized in 1960 and began to restrict export quantities of corrective lenses in 1962 and of sunglasses in 1963, such restriction continuing until 1968.

In 1964 a joint venture was started by the United States firm A.O.C. and a Japanese watch manufacturer for the production of double focus lenses in Osaka and three other areas. Then in 1968 the first joint factory of the lens manufacturing industry in Osaka was built in east Osaka as a project for upgrading smaller enterprises that was undertaken jointly by the Osaka Prefectural Government and the Agency

for the Promotion of Smaller Enterprises. It became the premises of the Japan Eyeglass Industry Centre, a cooperative association of the industry.

As for the situation with respect to supply and demand and exports since then, it has already been discussed in Chapter 3.

V. TECHNOLOGICAL PROGRESS IN THE EYEGLASS INDUSTRY - THE EXPERIENCE
OF THE EYEGLASS LENS INDUSTRY IN THE TAJIMA DISTRICT OF OSAKA

(1) Before World War II

As we have already noted, the Japanese eyeglass industry got started as a foreign transplant when Matsugoro Asakura in 1874 brought back eyeglass manufacturing equipment from the international exposition that had been held in Vienna the year before. Unfortunately there are no records of how the technology brought back by Asakura was transferred to the rather primitive lens making technology that had already been started by Tajiro Ishida in the Tajima area of Osaka.

TABLE 5. Japanese Eyeglass Product Exports

	Glass Lenses for Eyeglasses		Eyeglasses		Total	Frames & Parts
	Thousand Dozen	Million Yen	Thousand Dozen	Million Yen	Million Yen	Million Yen
1960		376		1,112	1,488	
63	1,014	445	1,167	1,169	1,613	
65	1,141	492	1,418	1,509	2,001	
66	1,215	625	1,664	1,902	2,528	
67	1,354	700	2,059	2,522	3,222	
68	1,291	789	2,212	3,001	3,791	
69	1,172	852	2,631	4,376	5,228	
70	1,080	953	3,089	6,113	7,066	849
71	1,460	1,299	2,550	5,395	6,694	1,471
72	1,525	1,517	2,571	5,631	7,148	2,336
73	1,711	1,858	2,167	4,606	6,464	4,508
74	1,890	2,114	1,959	5,871	7,985	4,710
75	1,547	2,341	2,162	8,279	10,620	4,333

Source: "Monthly Japanese Trade Tables", Ministry of Finance.

In the Meiji Period the Tajima area was still rural, and lens manufacturing in it was mainly a cottage industry in which independent and tenant farmers ground and polished lenses by hand as a side business when they were not busy with farming.

It was not until after the outbreak of the First World War when lens plate glass began to be produced domestically, that the lens industry in the Tajima area really blossomed. Furthermore, motors came into more prevalent use at about that time, and this resulted in a technological advance around 1925 from hand grinding and polishing to the use of power tools for this purpose.

A survey of smaller industries engaged in exports carried out by the Osaka Prefectural Commercial and Industrial Economic Research Institute in 1955 revealed that the technology and production methods employed in the eyeglass industry at that time and described below had been established around 1935.

The production method employed in the Tajima area of Osaka, known as C-type polishing, was a production method that allowed for production of a very large number of lenses per unit of time. It involved the use of two kinds of machines - a rough polisher and a finishing polisher - but they were the same structurally, differing only in terms of the kind of grinding plate and the size of mold attached. Generally, one man was able to operate four rough polishers and six finishing polishers.

TABLE 6. Osaka Prefecture Eyeglass Product Exports

	Sunglasses (with frames)		Lenses Polished on Both Sides		Total for Other Eyeglass Products
	Thousand Dozen	Million Yen	Thousand Dozen	Million Yen	Million Yen
1958 (Fiscal)					1,075
59					1,327
1960					1,462
61					1,469
62					1,687
63					1,810
64					1,929
65					2,153
66					2,586
67					2,896
68					3,250
69					3,885
1970	1,969	2,392	408	527	4,311
71	1,480	2,019	446	725	4,131
72	1,639	2,171	474	807	4,452
73	1,330	1,951	453	981	4,720
74	1,187	2,354	377	935	5,333
75	1,193	2,978	373	1,095	6,146

Source: Japan Eyeglass Promotion and Optical Instrument Inspection Association.

Note: Figures for Fukui Prefecture included in the figures up to and including fiscal 1962.

The production process sequence was roughly as follows:

Raw materials: Plate glass, blown glass

- | | | |
|---------------|---|----------------------------------|
| 1 Cutting | 2 Heat treatment (outside work done by order) | |
| {3 Attachment | 4 Rough polishing | 5 Finish polishing} Reverse side |
| {6 Attachment | 7 Rough polishing | 8 Finish polishing} Front side |
| 9 Inspection | 10 Packing | 11 Shipment |

First of all, round lens-size pieces of glass were carved out of the blown glass or plate glass, the former consisting of glass spheres with a diameter of 50-60 centimetres that are blown by mouth by specialists. As for the plate glass, it was mostly thick plate glass imported from Germany. The problem was that of making as many lenses as possible out of a unit of glass, and the cutting was therefore usually done by the owner himself or a member of his family. It was a simple matter to cut thin pieces of glass with a rotating glass cutter for weak eyeglass lenses and most sunglasses, but in the case of thick lenses, that is to say lenses with a stronger degree of correctiveness, and high-class sunglass lenses, the cutting had to be done by rule of thumb with an ordinary glass cutter.

The second process was heat treatment to get the necessary curve since even the curve of the blown glass was insufficient. The glass around the edges was made perfectly circular, and the thickness was kept constant. The method used was that of placing the cut piece of glass on a brick tray to be passed through a furnace for softening and then form pressing by air. This process was done by order outside the lens factory.

The third process was attachment. The lens was attached to a wooden piece which was rounded below and attached to the machine above. The rounded surface was concave for reverse side polishing, and the rest was convex for front side polishing. The lens was stuck to this wooden piece by means of a hard viscous concoction of pine resin, oil,

and ash. After being attached in this way by heating with charcoal fire or an electric warmer, the lens would remain securely attached for 10-15 days. One to seven lenses were attached at a time, depending on the curve, the number being smaller in the case of stronger lenses. Care had to be taken in the angle of attachment since this work would have a big influence on the finishing.

The fourth process was rough polishing by machine, and the fifth finish polishing. Here for the first time use was made of 1-5 hp motors, the horsepower depending on the number of machines.

The polishing started with rough polishing of the reverse side to get the necessary lens strength, followed by finish polishing. During both these polishing processes the lens remained fastened to the same wooden piece, which was attached to the machine and revolved in the opposite direction to the round cast-metal pieces below, in the case of rough polishing of the reverse side, that had the necessary curve with a protrusion in the middle in the opposite direction to the wooden piece. Emery powder was placed between it and the lens for polishing. The rough polishing was completed with two machines, using 4-5 kinds of emery powder in the order of coarser to finer grains.

In the finish polishing a piece with woollen cloth wrapped around it was used, the concavity and convexity being the same as in the case of the rough polishing. The polishing agent was colcothar. Three machines were used, including one for edge polishing and one for core polishing.

Once the reverse side polishing was completed, the front side polishing was done in the same way. When 5-7 lenses were attached, each machine set took 12-13 minutes, and that meant two to two and half hours in total for the five machines for the reverse side and the five machines for the front side. Since the work was a continuous flow, however, a set of lenses was completed every 12-13 minutes. Although physically the work was not very demanding, it required sustained concentration because of the high dependence on knack in achieving the necessary precision, and in many cases one man handled the whole series of processes from attachment of the lens to finish polishing of both sides. It took a man five years to become really skilled at this work, and if he could produce 100 dozen in 12-13 days, he could consider himself among the best.

Next came inspection. Eyeglass lenses were of no use or commercial value at all if they had the slightest clouding or defect. In processing, however, the lenses were covered with dust, emery, and colcothar, making it difficult to detect any defects that they might have. Furthermore, since the pressure at each point between the wooden piece and the grinding piece remained constant during the polishing process and each lens was ground down by the same amount, the original difference in the thickness of lenses attached to the same wooden piece remained after the finish polishing was completed. Some parts of the blown glass were thicker than others, and although an attempt was made to eliminate such differences at the time of attachment to the wooden piece, such differences in thickness were often discovered at

inspection. This made for a high reject rate of 10-15%, which indicates the limits to precision that could be expected of processing on the basis of human skill and knack. Inspection was by the naked eye, lens meter, thickness meter, and other instruments, and the lenses that do not qualify were either reworked or discarded. After inspection the lenses might be edged at the factory if so requested by the buyer, but in most cases this was done by the wholesaler or retailer. In the case of exports, almost all corrective lenses and all high-quality sunglass lenses were shipped without edging.

(2) Since World War II

Although the production method described above, which was established about 1935, was improved in some respects after World War II, up until the early 1960's there was still basic reliance on skill and rule of thumb. Only then was a big step forward made in eyeglass lens manufacturing technology of Osaka.

First let us consider the raw materials.

After 1965 plate glass as the raw material for making eyeglass lenses was replaced by blanks developed by large optical glass manufacturers and regularly supplied by them to lens manufacturers. This completely eliminated the need for cutting and heat treatment, such processes being included in the automatic production of the blanks, and the result was lower costs and guaranteed quality. Nevertheless, almost

half of the raw materials for lens manufacturing is still imported from the U.S. and Europe.

As for sunglass lenses, which were made from empty spheres of glass blown by human mouth or, in the case of higher-quality sunglasses, from imported color plate glass or polished lenses, such blown glass stop ed being used at all when, shortly after 1965 domestically produced color plate glass was developed on the basis of Ministry of International Trade and Industry and Osaka Prefectural Government subsidies and Japan Development Bank credits and met Japan Industrial Standards (JIS) and the industrial standards of other advanced countries.

Furthermore, there was development of plastic lenses from acrylic and acetylic resins chemically surface treated or tunicated. Although these plastic lenses allow for easy dyeing, they involve some technological problems that have yet to be resolved, and their future prospects are still in doubt, although promising.

Now let us consider the production processes, which are now as following as the result, in part, of innovations in raw materials:

- (1) Generation (rough grinding)
- (2) Blocking
- (3) Smoothing
- (4) Polishing
- (5) Finishing
- (6) Washing

In traditional low-speed polishing, processes (1) through (5) for astigmatic lenses and (2) through (5) for spherical (myopic and hyperopic) lenses are necessary for both sides of the lenses, and in this case the multi-card method with 6-8 polishing axes is employed.

Even now smaller manufacturers still basically use this method, except for the use of curve generators in the first process, although with some minor improvements.

As early as 1955 automated curve generators were introduced, reducing the time needed for generation by 75%, and with automatic adjustment in the smoothing and polishing processes skilled labor became unnecessary, and quality was immensely improved and standardized.

Large manufacturers and some smaller ones, on the other hand, have introduced high- and medium-speed polishing. In the case of smaller manufacturers, this was done with the guidance of the Osaka Prefectural Hall for the Encouragement of Industry, the first such high-speed polishers coming into practical use by smaller manufacturers around 1965. Features of this method are elimination of sanding in the blocking and generation processes as well as some other subprocesses, reduction of smoothing time to 7-15 sec. (10-40 min. with the low-speed method) and of polishing time to 90-120 sec. (1-4 hr. with the low-speed method), and simultaneous processing of both sides of the lenses.

In the case of some spherical lenses for which this method cannot

be applied, medium-speed polishing is done, with single-side processing from the blocking through the polishing processes, smoothing taking 4-15 min. and polishing 30-40 min.

Such differences in processing time requirements should not be taken entirely at face value, however, in view of the fact that the high-speed polishing is for only one lens at a time and even medium-speed polishing has few axes.

As for such formerly used polishing agents as emery, woollen cloth, and colcothar, they have been replaced by diamond foil, diamond pellets, air pressure, polyurethane, etc.

It will be difficult, however, to introduce such high- and medium-speed polishing in the case of smaller manufacturers in general unless in cooperative form since it is geared to mass production of a small number of products instead of the production in small lots of many different products that characterizes such manufacturers.

Accordingly, these smaller manufacturers have been coping with the situation in their own way, making improvements in low-speed polishing, developing comprehensive subcontracting on the basis of geographic concentration and the service of wholesalers as middle men, simplifying production by having generation and other processes done for them by others, and so on.

Sunglass lenses production involves mainly the cutting of color plate glass and curving. The machinery for doing this automatically and non-stop was developed by the Osaka Prefectural Hall for Encouragement of Industry in 1964 and adopted soon afterwards by large manufacturers, the Japan Eyeglass Industry Center joint factory established in east Osaka on the basis of the Law Concerning the Corporation for Promotion of Smaller Industries, and the joint facilities of the Western Eyeglass Cooperative, located in Ikuno Ward, Osaka.

These innovations have improved efficiency almost ten-fold and contributed enormously to standardization of product quality, but the fact should not be overlooked that they have required cooperative efforts on the part of smaller manufacturers.

Public technological testing and research facilities, working in close cooperation with the eyeglass industry, have played an important role in the technological progress that has been made by that industry in Osaka since the war.

Beginning in the mid-sixties, such institutions developed, with the participation of some private manufacturers, color plate glass, high-speed polishing, automatic, non-stop heat treatment (curving), reinforced glass to meet FDA requirements, and so forth, and since 1975 they have developed a test model device for automatic inspection of eyeglass lenses a method for coloration of ejection-formed eyeglass frames, a test model machine for automatic insertion of lenses, and other innovations.

In spite of such cooperation and effort on the part of these public facilities and the eyeglass industry itself, however, the business environment of the industry as a whole is deteriorating, the hardest hit area being Osaka.

Although this has been due in part to such structural factors as the small size of most of the firms in the industry, the system of subcontracting and reliance on outside processing, and the control over marketing exercised by wholesalers which have stood in the way of making the most of technological development and fashion trends, a more fundamental problem is industry attitudes toward research and development.

For the sake of design development and technological development and establishment of the kind of information system that both require, it will be necessary for both ongoing efforts on the part of individual firms and organized, cooperative efforts among groups of firms, the latter being indispensable to standardization and creation of production area brands.

The way in which these public technological testing and research facilities can be most helpful is by participating in various ways in this process and giving it the right orientation, which in turn will also keep them going in the right direction.

At the same time something will have to be done about such structural problems as the system of subcontracting and reliance on outside processing, the size of the firms in the industry, and the degree of cooperation and solidarity within the industry, and guidance in this respect will have to be forthcoming from management and economic research facilities as well.