8-21-1974

The Market in India for Optical Goods

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THE MARKET IN INDIA FOR OPTICAL GOODS

MASTERS THESIS
COLLEGE OF BUSINESS
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Research Option BBUB 771 and BBUB 772

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August 21, 1974

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CHAPTER I

INTRODUCTION

Until recently, market information was either not available or not needed in most international investment decisions. Uyterhoeven[1] suggests some of the reasons for the neglect of "marketing determinants", especially in underdeveloped countries. Historically, the reason for most overseas investment was to create a source of supply of raw materials to be used, not in the host country, but rather in the investors own market or in other industrialized nations. Thus, market information about the host country was never really needed.

"Another form of international investment, which was prevalent in the old days, was devoted to the creation of so-called overhead facilities, i.e., railroad and public utilities."[2] Once again, marketing dimensions were ignored because they were supplying clearly defined and already existing needs.

Since World War II, international marketing investments to supply markets in the host country itself have grown in importance. However, most of these investments were entered into largely for defensive reasons - to protect a market position which had

1. Uyterhoeven, Hugo, E.R., "Marketing Determinants of the International Investment Decision", Proceedings of the Winter Conference of the American Marketing Association, Dec. 27-28, 1963.

2. Ibid, p. 446.

previously been acquired through exports but which was jeopardized because of import restrictions. Since these investments were made to supply an already existing market position, the need for additional market information was less pressing when compared to other investment considerations. In addition, a large number of traditional investments were made in economies characterized by severe shortages. Whereas in a shortage economy selling one's goods rarely presents a problem, it is recommended that estimates on market size, market saturation levels and market growth potential be obtained before making substantial investments.

Today, these estimates are essential when investments in a foreign country are being considered, especially for products that are not included among the traditional consumer products. The same idea is stressed by Smith[3], who says that when launching new industrial products, "nothing beats an agressive, lively, appealing, all-out-effort - nothing except poor planning". Market research is needed to reduce the level of risk and uncertainty involved in making the decision to manufacture and sell a product in a foreign country.

For the purpose of this paper, we assume a hypothetical company, which has been in existence for only a few months. The management of this company is faced with the question "Should we manufacture and sell optical components or instruments in India?"

3. Smith, R.K., "Look First, Then Leap", Proceedings of the 48th National Conference of The American Marketing Association, June 14-16, 1965.

To meaningfully answer such a question, management will, to begin with, need inputs from almost all the various business functional disciplines, and then they will evaluate these inputs in terms of the company's goals, resources and attitude towards risk. The task of collecting and condensing all the information that management will need is indeed horrendous. However, there is usually an order in which this information is collected and presented to management. Among the first information that management will need is a "feel for the market". Accordingly, the scope of this paper is restricted to three functions:

a) Estimate the size of the total market for optical components and instruments in India.

b) Estimate the size of this market in 1980.

c) Identify a few optical products with good market potentials. No attempt will be made to establish the manufacturing feasibility or profitability of these products.

CHAPTER II

INTERNATIONAL MARKETING

The concepts and techniques used in international market research are no different than those used in domestic market research. The difference is that the international market researcher must understand the special environmental factors and institutions in the region of interest.[1] These special factors tend to increase the complexity of an already complex environment. This means that "foreign marketing research is more difficult, as a general rule, than domestic marketing research".[2]

One of the major difficulties of international market research is that published census and market data is usually scarcer and less reliable than in the United States. This problem becomes very acute when deáling with industrial products in a developing nation. In addition, two other problems become significant: "a) many trade associations will not make their data public, b) buyers in other countries are less used to cooperating in interviews".[3]

1. Kotler, P., "Marketing Management", Prentice Hall, 1972, p. 843.
2. Ibid, p. 854.
3. Ibid, p. 855.

Kracmar[4] feels that the inavailability of secondary data should not discourage the researcher. He claims that "It is in the nature of research in any field that the researcher obtains only a small fraction of the facts. The larger part must be produced by the researchers themselves... In business absolute accuracy is seldom necessary. What is important in the developing countries is that reasonably reliable data be forthcoming on which plans can be formulated with the assurance that they will not be entirely wrong".

Statistics, important as they are as a starting point, cannot by themselves provide the whole answer. There are many inputs about the environment and the industry that are needed in order to intelligently evaluate the market potential for any product.[5]

In the literature there are several definitions and interpretations of the term "market potential". For the purpose of this paper, the definition that will be used is, "Market potential indicates the relative strength or ability of a market to absorb a type of product or group of types of products for an entire industry".[6]

4. Kracmar, J.Z., "Marketing Research in Developing Countires", Prareger Publishers, 1973, p. 15.

5. Britton, H., "Directories and Census Data in Establishing New Product Potentials", Proceedings of the 44th National Conference of the American Marketing Association, June 20-22, 1962.

6. Hummel, F.E., "Principles and Techniques in Establishing Potentials for New Industrial Products", Proceedings of the 44th National Conference of the American Marketing Association, June 20-22, 1962.

CHAPTER III

ROLE OF THE GOVERNMENT

"The extremities of the spectrum of the organization of economic societies are (1) full command organization and (2) full market organization."[1] Under the former, economic organization is under a Central Plan through which all economic activities receive specific direction and order. Under the latter, order is achieved out of the interaction and coordination and responses of and to free decentralized choices and decisions. In practice, no economy is "pure". India has chosen to develop as a mixed economy, permitting both private and government-owned industries to assist in the country's development towards the ultimate achievement of a "socialistic pattern of society".[2]

India, like other developing countries, had to meet the challenge of compressing the progress of centuries within the span of generations.[3] The government has reserved for itself the role of developing basic industries. Thus, the steel, petroleum, transportation and mining industries, etc. are all in the public sector.

1. Grether, E.T., "Public Policy Affecting the Competitive Market System in the United States", Proceedings of the Fall Conference of the American Marketing Association, Sept. 1-3, 1965.
2. Clement, C.L., "Establishing a Business in India", Overseas Business Reports, OBR72-009. U.S. Dept. of Commerce, 1972.
3. Kulkarni, M.R., "Industrial Development", National Book Trust, India, 1971.

Also, the government can assume an entrepreneurial role in any industry that it deems important to the development of the nation and which is being neglected by the private sector. Thus, the government plays a very important role in the economy of India.

CHAPTER IV

THE ROLE OF THE PLANNING COMMISSION

The Planning Commission is a staff agency designed to prepare national plans for economic developments. These plans are divided into 5-year periods. The process of preparing a five-year plan is elaborate.[1] Initial analysis of the state of the economy and a review of production trends, rates of economic growth, etc. are undertaken about three years in advance of the start of a plan period. The Planning Commission then submits to the Cabinet for review a tentative rate of growth for the upcoming plan period together with a list of objectives and problems that deserve special attention. At the same time the Planning Commission sets up a series of working groups composed of its own specialists and others drawn from the various departments of the Federal and State governments as well as a few participants from outside the government. As a result of these efforts, a draft memorandum is prepared which highlights major policy issues for Cabinet consideration. After extensive review, the final report on the plan is presented to Parliament for approval.

The scope of the plan covers such subjects as financial resources, agriculture, irrigation, power, steel, fuel, education, scientific research, health, housing, etc. A section of the plan lists the

1. Honey, J.C., "Planning and the Private Sector", University Press of Cambridge, Mass., 1970, p. 14-15.

minimum growth rates that the various "industry groups" should achieve in the upcoming plan period if the overall objectives of the plan are to be met. These growth rates are easily translated into objectives for the industries in the public sector. In dealing with the private sector through the government assumes a "promotional or facilitative role"[2] to encourage the private sector to develop the areas that are lagging behind the planned rates of growth. Because of the very important role of government policy in the Indian economy, the planned growth rate of an industry is a good starting point when attempting to forecast its future.

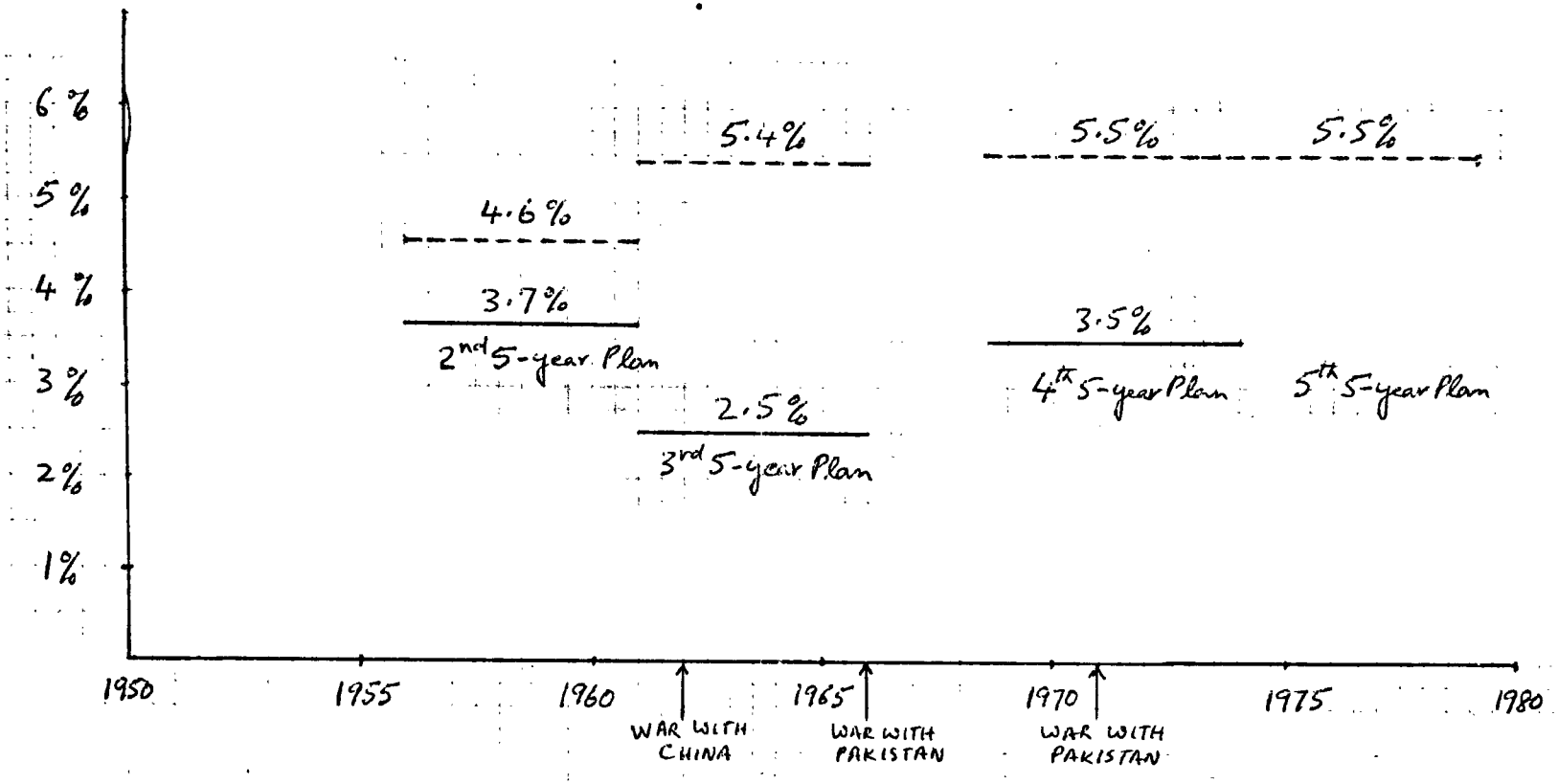
In the past the economy has not grown nearly as fast as the plans anticipated it would (see Exhibit 1). However, in recent years the government's planning experience suggests "a progression from dogma toward practicality".[3] In January Business Asia[4] predicted a 5% growth rate for 1974. If the after effects of the recent oil crisis do not continue for too long, it is hoped that by 1979 the planned growth rate of 5.5% may be achieved.

2. Bennett, P.D., "Marketing and Public Policy in Latin America", Proceedings of the Winter Conference of the American Marketing Association, Dec. 27-29, 1967.

3. Honey, J.C., "Planning and the Private Sector", University Press of Cambridge, Mass., 1970, p. 18.

4. Business Asia, Weekly publication of Business International, Jan. 18, 1974, p. 20-21.

INDIA'S AVERAGE ANNUAL GROWTH RATE *



* Dotted lines represent the 5-year Plan target and the solid lines represent the average annual growth rate achieved.

The economy was on an annual plan during 1966-69.

Source: Busuness Asia, Jan.18,1974, p19.

Fifth Five-Year Plan

The fifth five-year plan covers the period 1974-1979. The two basic themes of this plan are (1) self-reliance and (2) elimination of poverty. It would be naive to think that both these colossal problems can be overcome in the short span of five years. The goal of the plan is to reduce net foreign aid to zero by the 1979, i.e., at that time the only foreign aid needed will be used to repay the principal and interest on foreign debt. "Domestic technology has to play an important role in our development effort and drive for self-reliance... We should formulate a program of R&D and design engineering aimed at absorbing and building on imported technology... The plan provides for substantial expansion of engineering industries. It is envisaged that, besides developing the output of modern sophisticated plant and equipment, much more attention will be devoted to improving simple tools and implements of everyday use."[5] A concerted effort to implement such a policy will sharply increase the demand for scientific instruments. Thus, whereas the planned overall annual growth rate for the economy during the fifth plan (1974-1979) is 5.5%, the planned annual rate of growth for the scientific instrument industry is 10.1%[6] (see Exhibit 2).

5. Planning Commission, "Approach to the Fifth Plan, 1974-79", Government of India Press, January 1973, p. 16-22.

6. Ibid, p. 24.

EXHIBIT 2

5th Plan Projections:

	Annual Growth Rate
G.N.P.	5.5%
Agriculture	4.7%
Mining & Manufacturing	8.3%
Scientific Instruments	10.1%

Basic Theme of 5th Plan:

1) Self Reliance

2) Removal of Poverty

CHAPTER V

IMPORTANCE OF IMPORT STATISTICS

"The problem of foreign exchange control - that is, increasing the amount of foreign exchange available and controlling its use in order to accomplish development goals - is a pressing concern of the developing countries."[1] India has been suffering from a chronic balance of payments problem, which has been periodically worsened by large food imports and recently by the oil crisis. To reduce the gap between imports and exports, the government has imposed severe restriction of imports. "India has adopted an austere import policy, although imports of raw materials, components and spare parts for essential industries has been liberalized. Imports of a particular commodity are not permitted if there is adequate production in India of the same or similar goods. All imports require a license in order to enter India."[2] In addition, there are very high tarrif duties on most imported items.

The import statistics for the optical industry indicate the areas in which there is insufficient indigenous production (see Exhibit 3). Also, they indicate the demand level for particular items. Because of the severe import restrictions, it is reasonable to assume that the actual demand for these items would be many times the quantities imported.

1. Preston, L.E., "Market Development and Market Control", Proceedings of the Winter Conference of the American Marketing Association, Dec. 27-29, 1967.

2. Clement, C.L., "Establishing a Business in India", Overseas Business Reports, OBR72-009, U.S. Dept. of Commerce, 1972, p. 4.

India's Imports of Optical Goods*
(Value in Thousands of Rupees)
(Fiscal Year Begins April 1st)

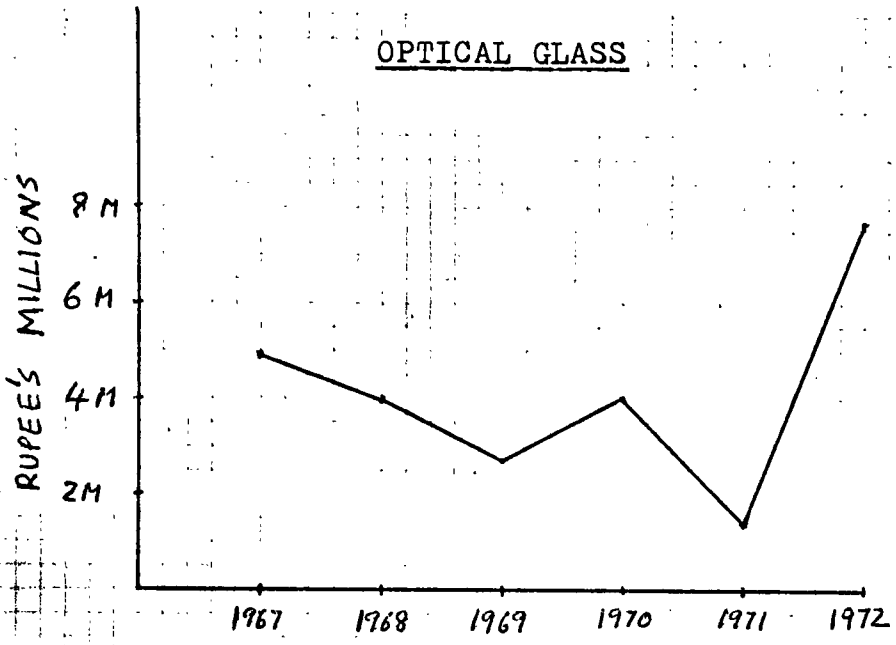
SITC Code	Commodity	1967	1968	1969	1970	1971	1972
Glass							
6642001	Blanks for Spectacle Lenses	3,531	2,808	1,269	3,626	618	6,073
6642009	Optical Glass, etc.	1,387	1,243	1,419	437	777	1,670
	Subtotal	4,918	4,051	2,688	4,063	1,395	7,733
Components							
8611100	Optical Elements Unmounted	130	14	38	65	69	20
8611201	Photographic or Projector Lenses	354	414	384	489	948	2,219
8611209	Optical Elements Mounted	193	437	300	564	468	564
	Subtotal	677	865	722	1,118	1,485	2,803
Instruments							
8613100	Binocular and Refracting Telescopes	151	254	245	268	275	800
8613201	Astronomical Instruments	38	-	-	99	63	240
8613401	Corneal & Ear Operating Microscopes	160	334	63	102	140	403
8613402	Dissecting Microscope	100	181	41	31	9	38
8613409	Other Microscopes	2,048	1,711	3,209	4,356	3,590	5,120
8613411	Microscope Parts	574	416	661	1,795	1,425	1,573
8613901	Telescopes	112	46	1,665	164	102	227
8613909	Other Optical Instruments	23,096**	1,940	4,686	6,295	1,353	5,936
	Subtotal	26,279	4,882	10,570	13,110	6,957	14,337
8619109	Surveying Instruments	1,223	606	446	734	1,062	5,465
8619311	Profile Projectors	280	137	209	141	223	1,285
8619801	Polarimeters	170	377	127	684	54	271
8619802	Refractometers	105	140	159	184	234	323
8619803	Spectrometers	2,170	1,044	2,029	4,170	5,580	5,427
8619821	Photometers	834	731	452	1,275	1,074	1,088
	Subtotal	4,782	3,035	3,422	7,188	8,227	13,859
	Grand Total	36,656	12,833	17,402	25,479	18,064	38,732

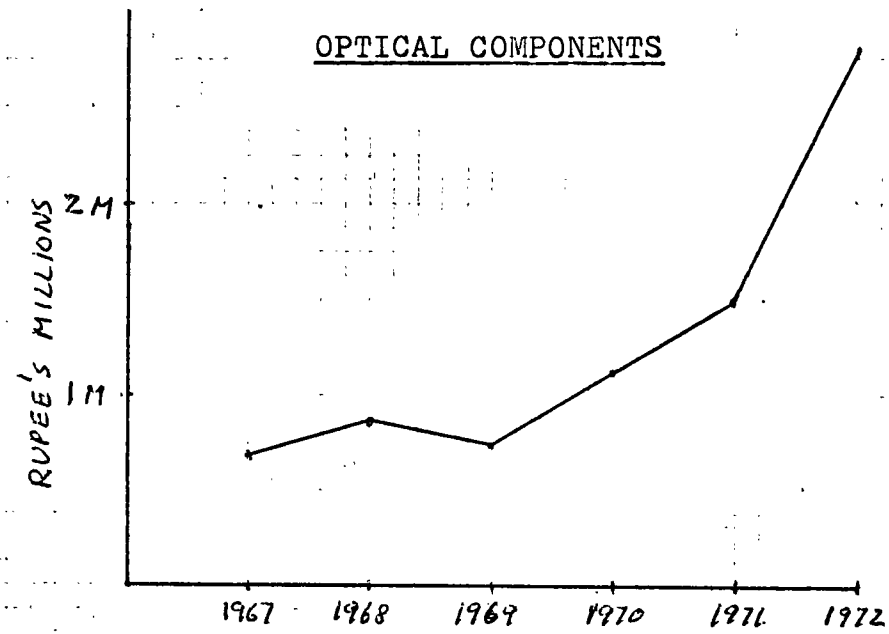
* Figures for imports of photographic and cinematographic cameras and projectors have been excluded from this listing.

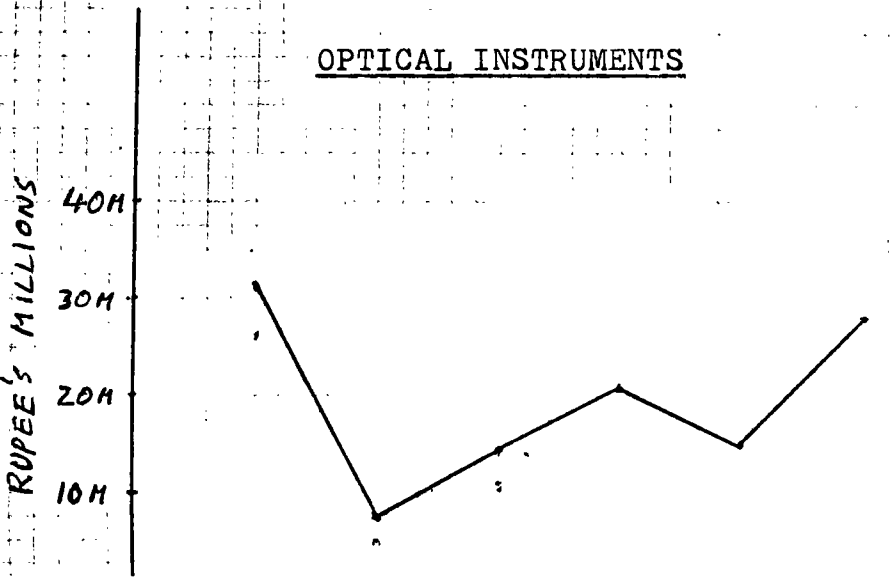
** An unusually large order of Rs 20,715,567 for "other optical instruments" was imported from Japan in 1967.

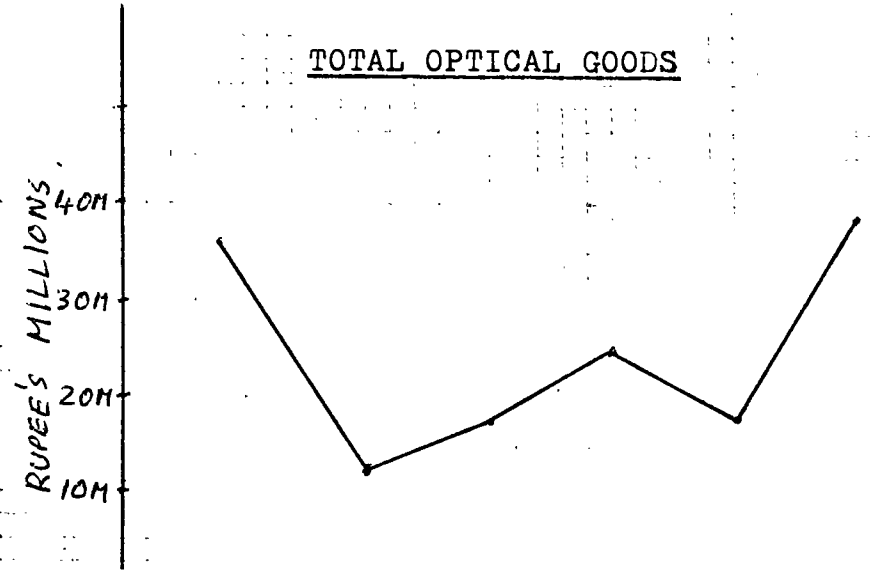
EXHIBIT 3A

INDIA'S IMPORTS OF OPTICAL GOODS









CHAPTER VI

INDUSTRIALIZATION OF INDIA

One of the primary goals of the second and third 5-year plans was the development of agricultural production and the establishment of basic industries. It appears that the era of agricultural self-sufficiency is finally approaching; in three of the last five years no net imports of agricultural produce were necessary. However, as long as irrigation facilities are lacking in most of India, its harvest will continue to be unpredictable.

In the fifth 5-year plan the emphasis seems to be shifting from agriculture towards industrialization (see Exhibit 2). Kotler[1] classifies the world's economies as a) Subsistence Economies, b) Raw material exporting economies, c) Industrializing Economies, and d) Industrial Economies. On this scale he rates India as an Industrializing Economy, with manufacturing accounting for between 10 and 20% of the gross national product. This need for industrialization is apparently a world-wide phenomenon. "What alchemy was to the Middle Ages, industrialization is to the underdeveloped world."[2] "The development of an economy, at its

1. Kotler, P., "Marketing Management", Prentice Hall, Inc., 1972, p. 844.

2. Bennett, P.D., "Marketing and Public Policy in Latin America", The proceedings of the Winter Conference of the American Marketing Association, Dec. 27-29, 1967.

core, consists in the progressive diffusion of the fruits of modern science and technology. Industry is the most dramatic form which modern science and technology assumes."[3]

If this trend towards industrialization continues and it is not hampered by wars or natural disasters, it will greatly benefit the instrument industry in general. There will be an increased demand for optical instruments, for inspection, comparison, measurement, analysis and process control purposes.

"Technological transformation can be hastened only if adequate attention is given to research and development."[4] The technological development pace set by the industrialized nations is indeed very fast. If India hopes to catch up, it has to do more than copy existing processes; it has to innovate, and the smaller the technological gap becomes, the greater will be the need for more research and development. Also, as the program for industrialization matures, the technological research efforts of the government institutions will be supplemented by R&D efforts of industry.[5] The implication of such efforts for the scientific instrument industry are obvious.

3. Rostow, W.W., "The Concept of a National Market and its Economics Growth Implications", Proceedings of the Fall Conference of the American Marketing Assoc., Spt. 1-3, 1965.

4. Kulkarni, M.R., "Industrial Development", National Book Trust, India, 1971, p. 280.

5. Bennett, P.D., "Marketing and Public Policy in Latin America", Proceedings of the Winter Conference of the American Marketing Association, Dec. 27-29, 1967.

CHAPTER VII

A PROFILE OF THE PRINCIPAL USERS OF OPTICAL GOODS

The principal users of optical goods in India are:

1) Scientific Research Organization
2) The Department of Defense
3) The Educational Institutions
4) The Manufacturing Industries

Scientific Research Organizations

The need for optical goods in scientific research ranges from the simple optical components to highly sophisticated optical systems. Optical instruments are used by researchers in the fields of physics, chemistry, astronomy, metallurgy, engineering, biology, medicine, etc.

About 92% of the R&D expenditures in India is financed by the public sector.[1] It is some of these prestigious government institutions that are conducting research at the frontiers of technology, and their demand for more sophisticated equipment will continue to increase as their funding increases (see Exhibit 4).

Department of Defense

Optical instruments and devices are used by the Department of Defense for sighting, ranging, tracking, surveillance and identification purposes. A typical list of such devices would include

1. Planning Commission, Govt. of India, "The Fourth Plan, (Midterm Appraisal)", Feb. 1972, p. 118.

binoculars, telescopes, periscopes, weapon sights, range finders, night vision devices, aerial reconnaissance systems, etc. Data on defense expenditures for such devices is not available. Whereas, in the past most of defense needs were imported; in recent years the government has been pushing for the indigenous manufacture of the simpler systems.[2] Thus, it is reasonable to assume that the rate of procurement of optical systems will increase faster than the overall defense budget (see Exhibit 5).

Educational Institutions

Optical components and instruments are used by schools and colleges mainly in the teaching of "science courses". They are used for demonstration purposes and by students in performing laboratory experiments. Because of the severe financial limitations under which most of these institutions operate, it is assumed that the instruments purchased by them would tend to be inexpensive and of generally poorer quality.

In 1966 it was estimated that "the annual requirements of scientific instruments for replacement, improvement and expansion in educational institutions including the science and medical colleges and engineering colleges and polytechnics was 150 million".[3]

2. Indian Institute of Public Opinion, "Engineering Industry in the Seventies", Monthly Commentary on Indian Economic Conditions, Vol. XII, No. 1, Aug.-Spt. 1970, p. 1.

3. Planning Commission, "Programs of Industrial Development, 1961-1966", Govt. of India Press, p. 153.

However, no information is available on what fraction of the total requirement was for optical instruments. The rate of increase of student enrollment in science courses at the university level is shown in Exhibit 6.

Manufacturing Industries

Optical instruments are used in industry for measuring, gaging, inspection, chemical analysis, and for controlling online manufacturing processes. In the past the quality control function has in general been neglected, because demand has outstripped production in many industries. However, as the industries mature and the gap between production and demand narrows, the quality control aspect of manufacturing will begin to be emphasized. The growth of the manufacturing industry is depicted in Exhibit 7.

EXHIBIT 4

AVERAGE ANNUAL PUBLIC SECTOR OUTLAY FOR SCIETIFIC RESEARCH
(in millions of rupees)

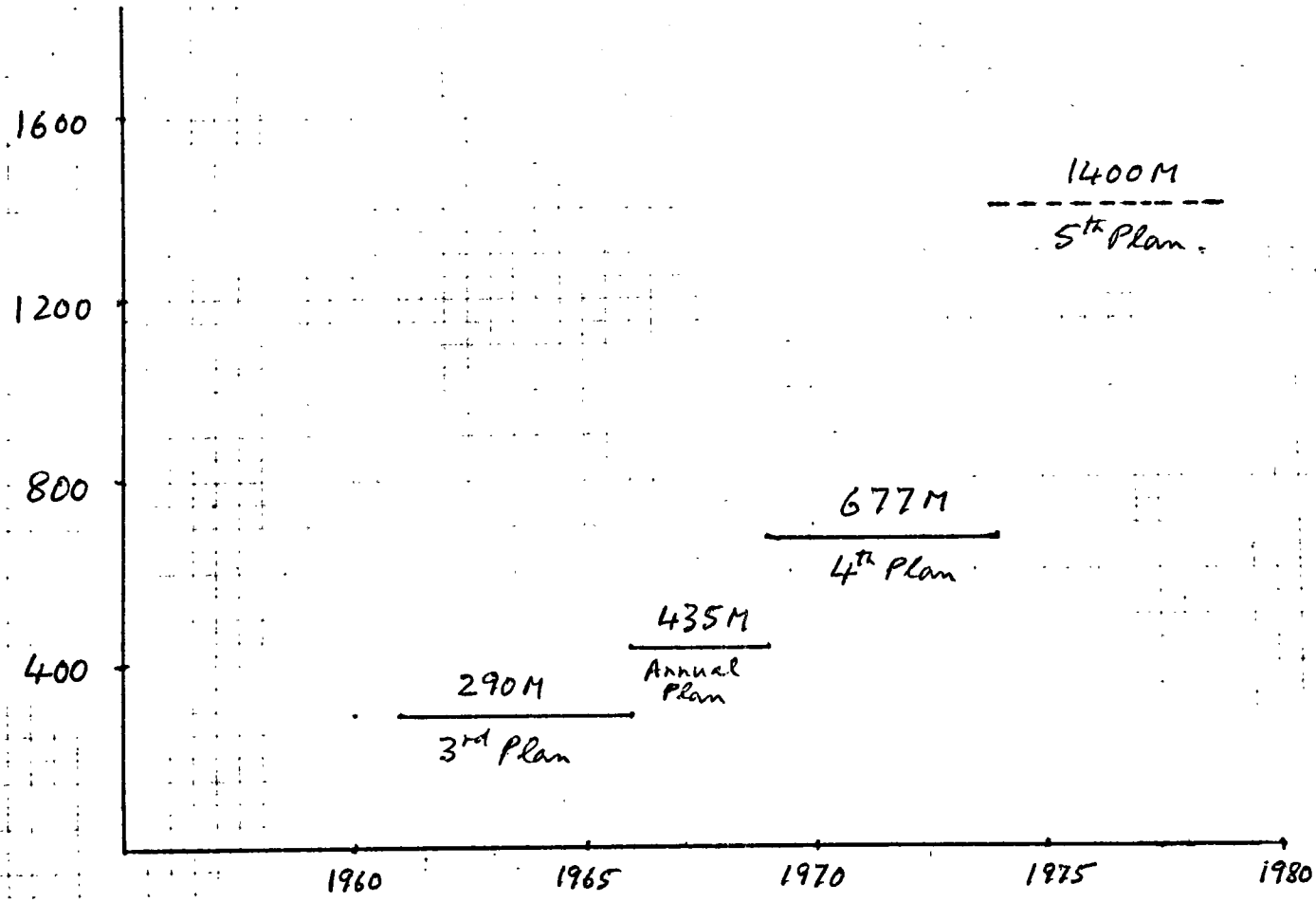


EXHIBIT 5

INDIA'S CAPITAL EXPENDITURES FOR DEFENSE

(Millions of Rupees)

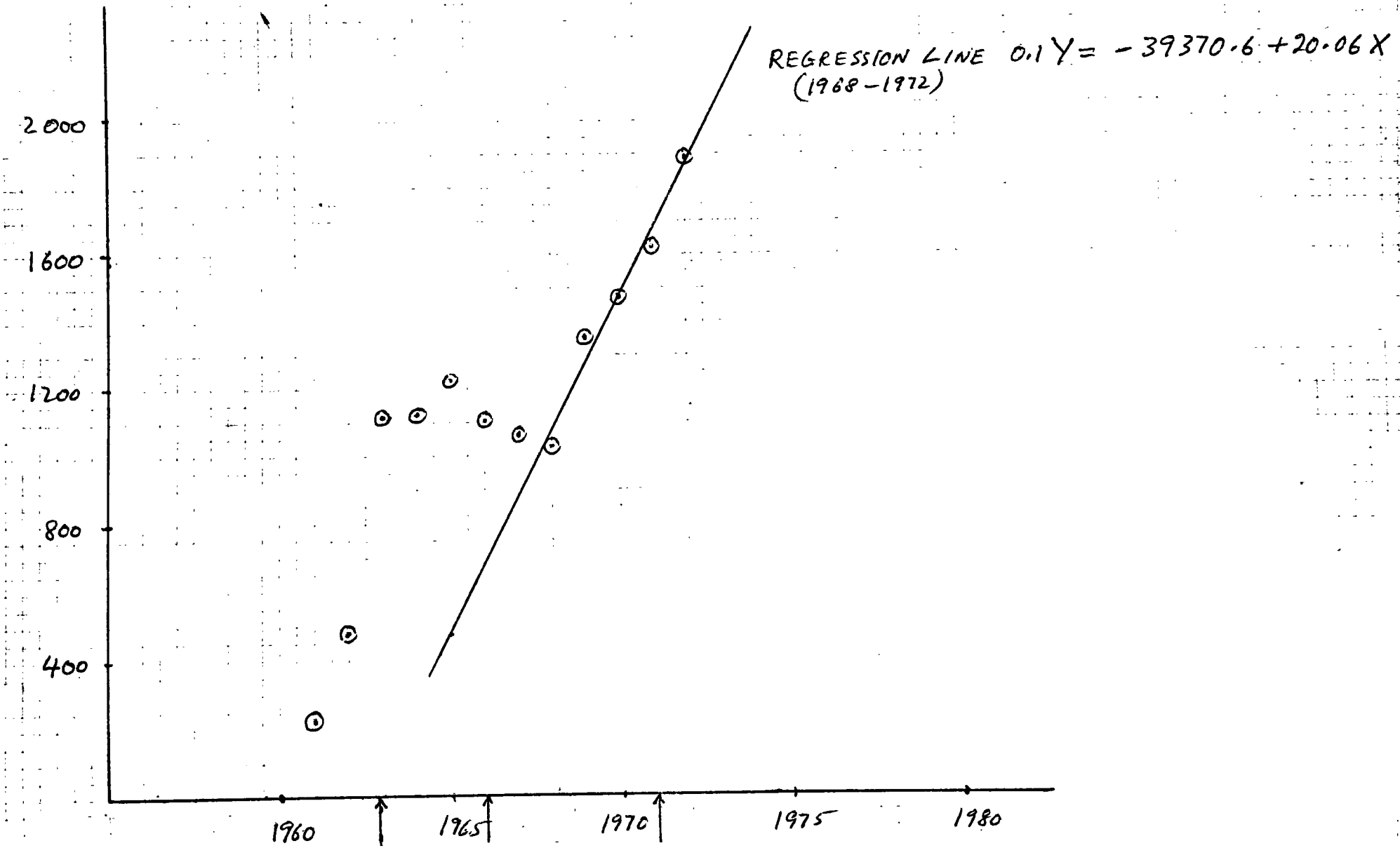


EXHIBIT 6

UNIVERSITY ENROLLMENT IN SCIENCE COURSES
(millions)

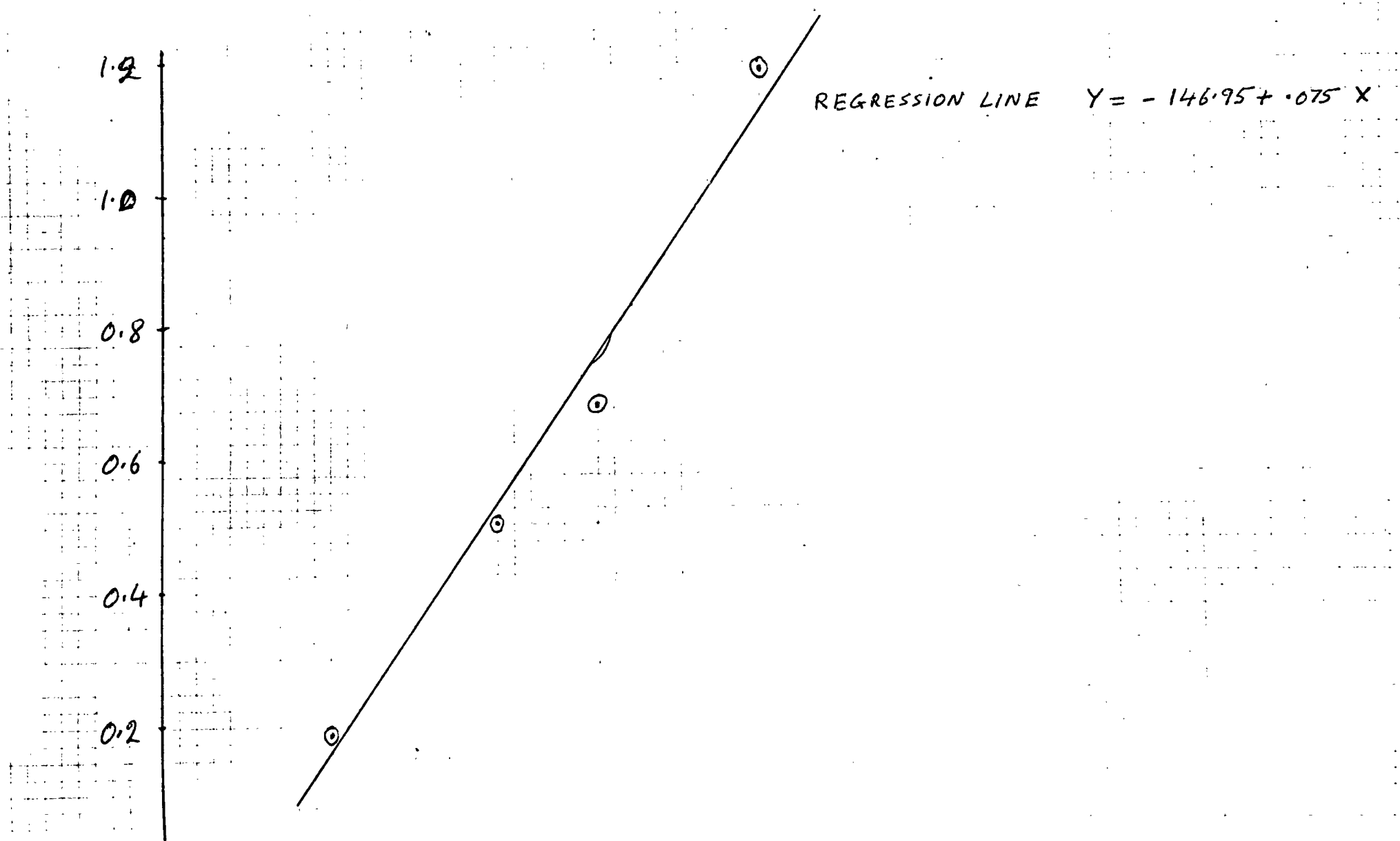
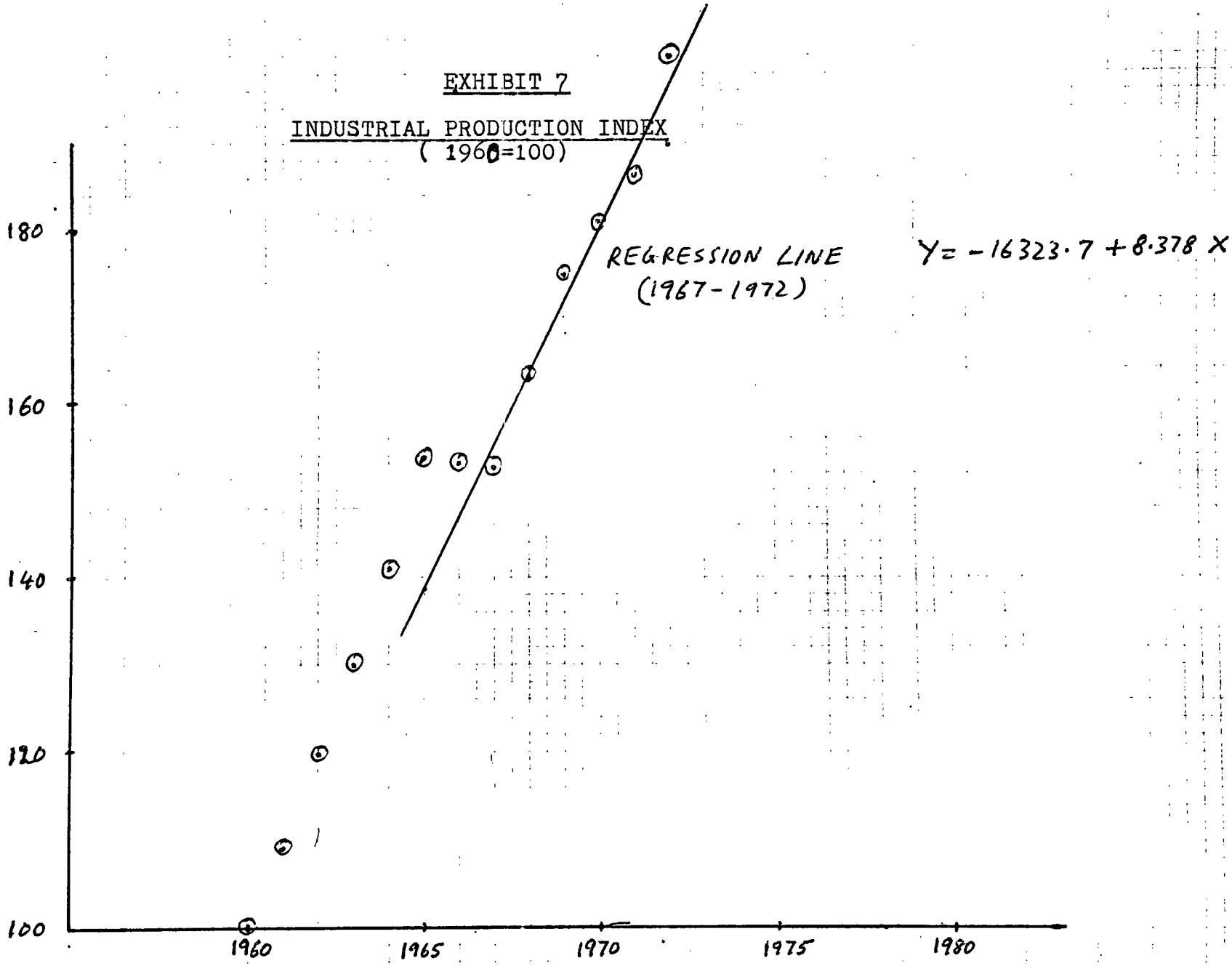


EXHIBIT 7

INDUSTRIAL PRODUCTION INDEX
(1960=100)



CHAPTER VIII

RESEARCH METHODOLOGY

Quest for Secondary Data

The goal of the initial phase of this study was to obtain suitable secondary data. Library searches were conducted at the local libraries as well as at the Library of Congress in Washington D.C. Secondary data was also obtained from The Embassy of India, The Bureau of International Commerce, The United Nations Statistical Service and the international marketing division of a local optical instrument manufacturer. Unfortunately, most of this data was not suitable for this research project. The "closest" classification to optical components and instruments was entitled Scientific Instruments. This classification covers a wide range of instruments and there is no apparent way of breaking down the data in terms of optical instruments. However, the following useful information was obtained through the search for secondary data.

1) Statistics on India's imports of optical components and instruments.
2) Trend information on the principal users of optical goods.
3) The business environment in India and the importance of government plans and policies when attempting to forecast the future.

Quest for Primary Data

When it became apparent that the secondary data available was inappropriate, it was decided to obtain some primary data. The process of acquiring the primary data was split into two parts.

The first part was concerned with estimating the total market for optical goods in India. It was felt that the optical good's manufacturers in India would have the most accurate and up-to-date information on this subject. Therefore, ten manufacturers of optical instruments in India were contacted and asked to estimate the total market. In addition, the Optical Manufacturers Association in the U.S. and publications like Business International, Business Asia and Asia Letter were also queried. A typical letter is shown as Exhibit 8.

The second part was concerned with obtaining answers for the remaining objectives of this paper. The sample for this study consisted of scientists in India who were members of the Optical Society of America or The Society of Photo-Optical Instrumentation Engineers. There were only 33 such individuals; and therefore, it was decided to include all of them in the survey. This sample may be slightly biased, because the scientists in India who belong to foreign professional societies would probably be among the prominent scientists in India; and therefore, their needs would tend to be towards more sophisticated optical instrumentation. However, this bias should not significantly affect the results of this survey.

The major disadvantage of the mail survey is the non-response problem.[1] However, in this case a mail survey was the only practical method of conducting the survey. Therefore, 33 appropriately designed questionnaires were mailed out between May 24, 1974 and June 12, 1974. A copy of the survey instrument is attached under Appendix A. Indian postage stamps were obtained and stamped return envelopes were enclosed with each questionnaire in an effort to reduce the non-response problem. Since the time for completion of this study is limited and because of the long transit time for the mail (7 to 10 days), no reminders will be sent to the non-respondents.

Design of the Questionnaire

The questions on Page 1 of the questionnaire are intended to provide information regarding the background of the respondent and also his contacts with the marketplace.

Question 1 on page 2 and question 1 on page 4 should provide a figure for the percentage of imported optical goods in the Indian optical market. This figure will be used as a check on the figure for the total optical goods market that is obtained from the optical manufacturers in India. In other words:

1. Simon, J.L., "Basic Research Methods in Social Science", Random House, 1969, p. 249.

$$\left(\begin{array}{l}\text{The average percentage of}\\ \text{imported optical goods}\\ \text{obtained in response to}\\ \text{question 1 on page 2}\\ \text{and 4}\end{array}\right) \approx \frac{\left(\begin{array}{l}\text{Total optical imports}\\ \text{obtained from Exhibit3}\end{array}\right)}{\left(\begin{array}{l}\text{The total optical goods}\\ \text{market as estimated by}\\ \text{the optical instrument}\\ \text{manufacturers in India}\end{array}\right)}$$

Question 3 on page 2 and question 2 on page 4 should provide information on the relative importance of the various users of optical goods. This information coupled with the anticipated growth rate of these users will be used to forecast the market for optical goods in 1980. The major assumption is that the same "causal factors" that exist today will exist in 1980 and that they will carry the same weight.

The responses to question 4 on page 6, question 3 on page 5 and question 4 on page 3 should help determine the products with good market potential in India.

EXHIBIT 8

15A Greenleaf Meadows
Rochester, N.Y. 14612
April 28, 1974.

Optical Manufacturers Assoc.
30 East 42 Street
New York, N.Y. 10017.

Sirs,

I am involved in a project that will be studying the market for optical components and instruments in India. This study is being conducted at the Rochester Institute of Technology, under the guidance of Prof. F. Pallischeck.

Since not much is known about scientific instrument manufacture in India, we would greatly appreciate your help in this project. We need to know the names and addresses of the manufacturers of optical instruments and components in India, along with a listing of their products. Any descriptive brochures or catalogues of their products would be extremely helpful. Statistical data about India's production of optical components and instruments will also be very useful.

I thank you in anticipation of your co-operation in this project.

Very truly yours,

P. S. Bhullar.

P. S. Bhullar.

CHAPTER IX

ANALYSIS OF RESULTS

Size of the Market for Optical Goods

Of the ten manufacturers of optical instruments in India that were asked to estimate the market for optical goods in that country, only two responses contained specific information on market size. It appears that either they did not know the approximate size of their industry's market or they were unwilling to disclose data about their industry.[1] If the latter is true, then the bias in the data obtained would probably be towards the low side. The two estimates of market size that were obtained are Rs 45 million and Rs 125 million. Some of the wide variation in these figures could be because of the respondents own definition of "the total market for optical instruments and components".

An independent estimate of market size can be obtained by using some of the data obtained in response to the questionnaire in Appendix A along with the Import Statistics in Exhibit 3. Data on the percentage of the respondents budget for optical goods, which is spent on imported optical components and imported optical instruments, is summarized in Exhibits 9 and 10, respectively.

1. Kotler, P., "Marketing Management", Prentice Hall, 1972, p. 855.

EXHIBIT 9

Percentage of Respondents Budget Spent on Imported Optical Components

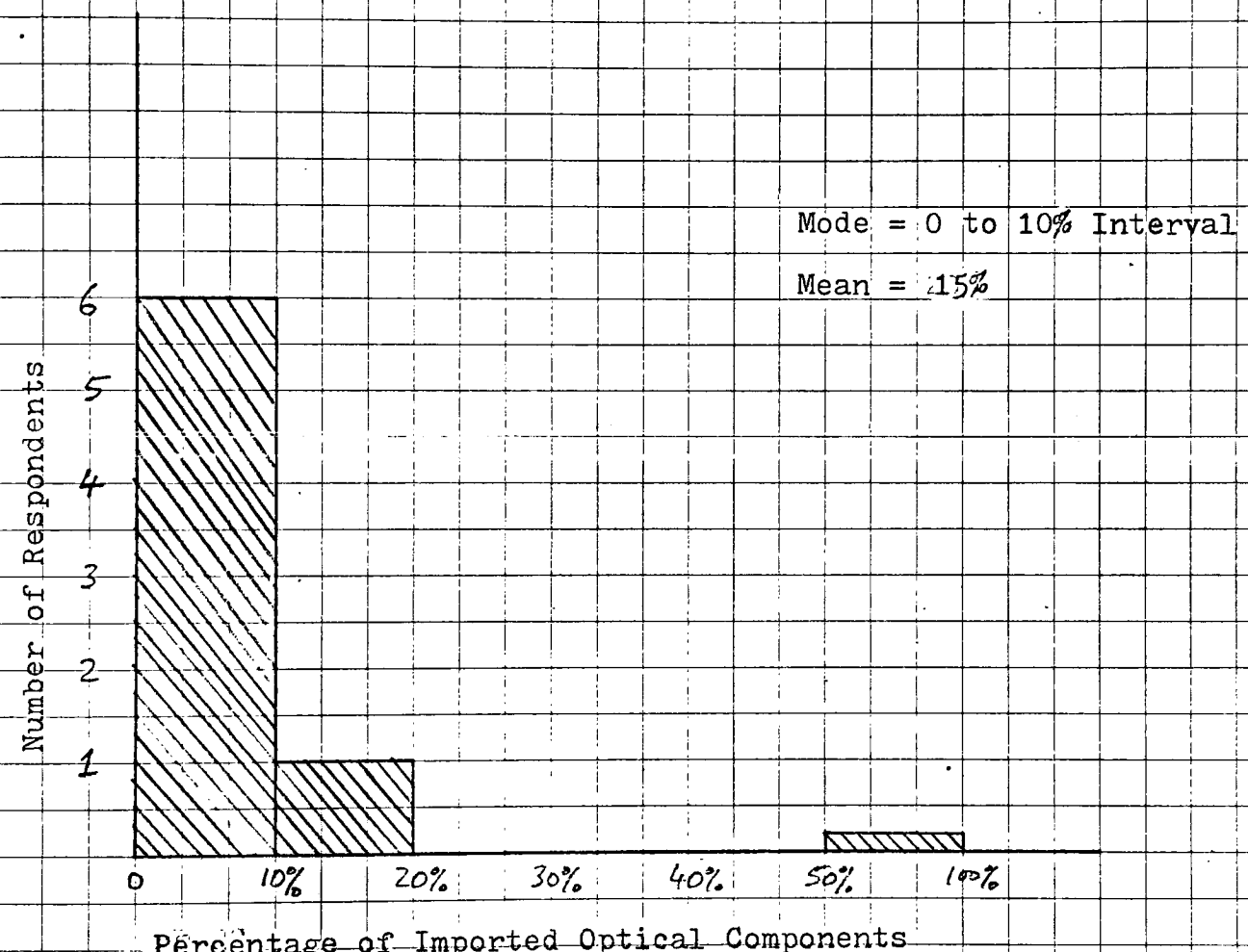
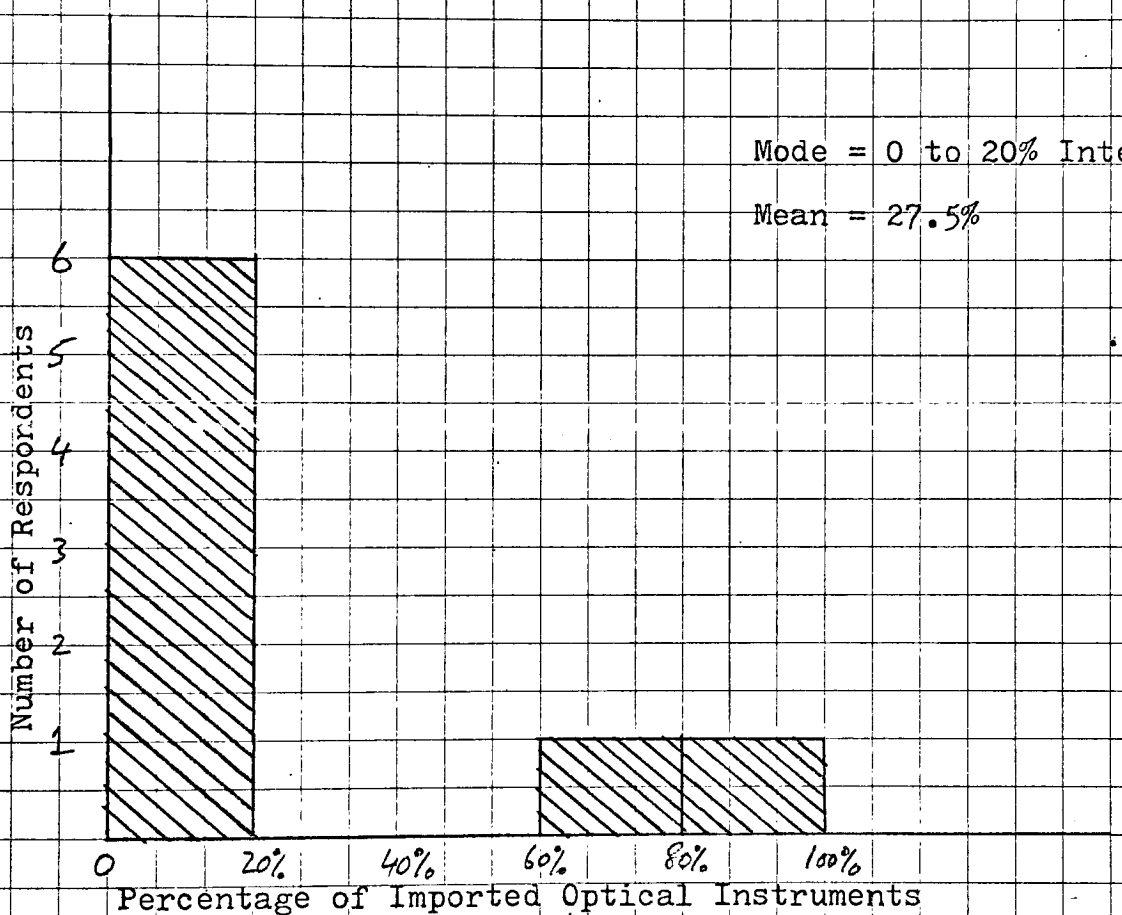


EXHIBIT 10

Percentage of Respondents Budget Spent on Imported Optical Instruments



The mean value of the percentage of the respondent's budget spent on imported optical components or instruments is useful only if the total budget of each respondent was the same. Therefore, the mode will be used for the calculations below.

The modal class in Exhibit 10 is 0-20%; and therefore, it is assumed that the mode lies midway in the interval, i.e., at 10%. The modal class in Exhibit 9 is 0-10%, but in this case primarily for ease of computations it is assumed that the mode lies at 10% rather than midway in the interval. The result of such an assumption would be a slightly lower estimate for the total market for optical goods.

The equation described on page 20 may be rewritten as:

$$\left(\begin{array}{l}\text{Total market for}\\ \text{optical goods in}\\ \text{India}\end{array}\right) \times \left(\begin{array}{l}\text{Imports as a percentage}\\ \text{of the respondent's total}\\ \text{budget for optical goods.}\\ \text{From Exhibits 9 and 10.}\end{array}\right) = \left(\begin{array}{l}\text{Total imports}\\ \text{of optical}\\ \text{goods into}\\ \text{India. From}\\ \text{Exhibit 3.}\end{array}\right)$$

or

$$\left(\begin{array}{l}\text{Total market for}\\ \text{optical goods in}\\ \text{India}\end{array}\right) = \frac{\left(\begin{array}{l}\text{Total imports of}\\ \text{optical goods}\\ \text{into India}\end{array}\right)}{\left(\begin{array}{l}\text{Imports as a percentage}\\ \text{of the respondent's total}\\ \text{budget for optical goods}\end{array}\right)}$$

Upon substitution of figures from Exhibits 3, 9 and 10 in the above equation:

$$\begin{pmatrix}\text{Total market for optical goods in India 1972-1973}\end{pmatrix} = \frac{\text{Rs 38 million}}{0.10} = \text{Rs 380 million}$$

This estimate of Rs 380 million for the total market for optical goods in India is much higher than those obtained from optical instrument manufacturers in India. The validity of the above equation depends upon whether the "percentage of imported optical goods" obtained from the respondents to the questionnaire can be considered to be representative of all the users of optical goods in India. Since the sample consists of prominent scientists in India, their needs for sophisticated equipment would be higher than for the rest of the population; and therefore, the bias in the "percentage of imported optical goods" obtained from them would tend to be towards the high side. Any attempt to measure this bias and then to remove it, would only tend to increase the figure of Rs 380 million for the total market for optical goods in India.

Another source of error in the figure used for "percentage of imported optical goods" is that it is based on a small sample of eight respondents. In the absence of information about the

respondent's total budget for optical components and instruments, the mean values calculated in Exhibits 9 and 10 are meaningless; and hence, it is not possible to calculate the variance of the sample or the mean. Nevertheless, the distributions in Exhibits 9 and 10 indicate that there could be considerable error in using the figure for "percentage of imported optical goods" obtained from the sample as a representative figure for the entire population.

It is difficult to estimate with reasonable accuracy the size of the total market for optical goods in India because of the wide range of figures that have been obtained and because of the errors in the estimation processes. However, it appears that the size of the total market for optical goods in India is most probably between Rs 125 million and Rs 380 million.

Estimate of the Size of the Market for Optical Goods in India in 1980

In the absence of historical data on the size of the market for optical goods in India, it is not possible to use any of the "naive" forecasting models (like trend projections, moving averages, exponential smoothing, etc.) to estimate the size of this market in 1980. Even if such data were available, appropriate causal models are preferable to "naive" models. "The causal model

relates sales to other variables which, in essence, makes the problem one of forecasting "other variables", and using these forecasts to estimate sales."[2]

The causal factors have already been listed and their growth rates estimated in Chapter VII. The relative contributions of these causal factors to make up the total market for optical goods in India can be deduced from the responses to question 3 on page 2 and question 2 on page 4 of the questionnaire. The responses to these questions have been summarized in Exhibits 11 and 12. The development of a Causal Forecasting Model is carried out in Appendix B.

The results of the calculations carried out in Appendix B are:

a) The sales of optical components in 1980 will be 1.66 times the sales of optical components in 1973. This is equivalent to a compounded annual growth rate of 7.5%.

b) The sales of optical instruments in 1980 will be 1.73 times the sales of optical instruments in 1973. This is equivalent to a compounded annual growth rate of 8.1%.

2. Armstrong, J.S., "Long-Range Forecasting for International Markets: The Use of Causal Models", Proceedings of the Fall Conference of the American Marketing Association, 1968.

These figures are low compared to the annual growth rate of 10.1% for the scientific instrument industry that is predicted by the Planning Commission for the Fifth Five Year Plan, 1974-1979 (Exhibit 2).

One basic assumption made while forecasting the size of the market for optical goods in 1980 is that the causal factors remain unchanged. Also, the growth of these market segments has in most cases been projected from historical data, and it has been assumed that the growth of a market segment will be matched by an equivalent increase in optical goods sold to it. As has been pointed out earlier in Chapter VII, this assumption may not be totally valid. Since the optical industry in India is still in the early parts of its life cycle, it should have a higher growth rate than its principal consumers. Therefore, it appears that the estimates for the size of optical goods market in 1980 are on the low side.

It should be pointed out that no allowance has been made for natural disasters, wars or significant shifts in government policy which would significantly affect these predictions.

EXHIBIT 11

RELATIVE CONSUMPTION OF OPTICAL COMPONENTS

	Government					Industry	
Respondent	Research Institutions	Defense	Other	Educational Institutions	Private Research Institutions	Instrument Manufacturers	Other
1	0.05	0.05	0.00	0.10	0.00	0.35	0.00
2	0.20	0.60	0.00	0.05	0.10	0.05	0.00
3	0.25	0.20	0.05	0.20	0.20	0.08	0.02
5	0.20	0.50	0.00	0.10	0.10	0.10	0.00
6	0.10	0.20	0.00	0.10	0.20	0.40	0.00
7	0.10	0.15	0.35	0.15	0.05	0.10	0.10
9	0.05	0.10	0.05	0.15	0.15	0.50	0.00
12	0.20	0.25	0.05	0.15	0.10	0.20	0.05
Average Consumption	0.144	0.313	0.062	0.125	0.112	0.223	0.021

EXHIBIT 12

RELATIVE CONSUMPTION OF OPTICAL INSTRUMENTS

Respondent	Government			Educational Institutions	Private Research Institutions	Industry
	Research Institutions	Defense	Other			
1	0.15	0.35	0.00	0.10	0.00	0.40
2	0.20	0.60	0.00	0.15	0.03	0.02
3	0.20	0.15	0.05	0.40	0.15	0.05
5	0.25	0.50	0.00	0.05	0.20	0.00
6	0.30	0.30	0.00	0.10	0.20	0.10
7	0.45	0.20	0.10	0.15	-.05	0.05
9	0.10	0.15	0.05	0.25	0.15	0.30
11	0.10	0.45	0.10	0.15	0.10	0.10
12	0.25	0.35	0.05	0.10	0.10	0.15
Average Consumption	0.222	0.339	0.039	0.161	0.109	0.013

Optical Products With Good Market Potential

The responses to question 4 on page 3 of the questionnaire indicate that optical flats, mirrors, prisms and lenses manufactured in India are of reasonable quality for most purposes and are generally available in sufficient quantity. Whereas the technology for manufacturing precision optical components in India is available, it is not being fully utilized because of limited variety of glass that is available for optical design. Diffraction Gratings and Fiber Optics are not at present being manufactured in India.

The responses to question 3 on page 4 of the questionnaire indicate that the simpler and less expensive optical instruments like general purpose microscopes, telescopes, colorimeters, refractometers and polarimeters of reasonable quality for most purposes are being manufactured in India. The remainder of the instruments listed like radiometers, spectrophotometers, microdensitometers, etc. were either not manufactured or compared poorly with similar imported instruments.

Some optical products having high unfulfilled demand that were recommended by the respondents are listed in Exhibit 13. Most of these categories cover a wide product range in terms of applications and price, and therefore the variance in the annual demand quantities. It is interesting to note that three of the

highly recommended products, spectrometers, photometers and optical glass together account for a significant proportion of India's imports of optical goods (Exhibit 3). However, before a product can be chosen for manufacture, it will be necessary to conduct in-depth market and feasibility studies. Nevertheless, Exhibit 13 does narrow down the wide field of optical goods to a few products that should be further investigated.

EXHIBIT 13

RECOMMENDED PRODUCTS

	Product	No. of Respondents Recommending Product	Estimate of Annual Demand
1.	Optical Glass	6	-
2.	Spectrophotometers and Radiometers	8	50 to 3000
	Monochromators	1	100
	Diffraction Gratings	3	-
3.	Densitometers	3	100 to 2000
4.	Lasers (He-Ne)	3	1000 to 10000
5.	Interferometers	2	30 to 500
6.	Phototubes	3	200
7.	Image Intensifiers	2	1000
8.	Thin Film Coatings	1	-

CHAPTER X

CONCLUSION

The purpose of this project was to "obtain a better feel for the market". This objective to a large extent has been met by the information obtained in the process of doing the research. It is rare for a researcher to obtain all the information he will need for making an important decision; and the information provided by this research serves as a good "starting point". Some of the important conclusions reached in this paper are:

a) The optical component and instrument market in India is probably in the range of Rs 125 million to Rs 380 million in annual sales.

b) This market will grow at about 7-8% annually for the next 6 years.

c) The demand for most optical components and simple optical instruments is being met by indigenous production. There appears to be some demand for more varieties of optical glass, diffraction gratings, spectrometers, radiometers, photometers and microdensitometers. However, before a product decision can be made, it will be necessary to conduct more detailed market and feasibility studies for these products.

APPENDIX A

RESEARCH INSTRUMENT

15A Greenleaf Meadows
Rochester, N.Y. 14612
May 24, 1974

Dear Mr.

We are conducting a survey among leading scientists in the optical field in India. The purpose of this study is to determine the current status and future potential of the Indian optical industry. It is hoped that the publication of the results of this survey will lead to a strengthening of the weaker segments of the industry.

This study is being conducted at the Rochester Institute of Technology under the guidance of Prof. F. Pallischeck. Your name, as a leading scientist in India, was given to us by the Optical Society of America.

It will take only a few minutes of your time to check the answers to the simple questions on the enclosed questionnaire and then return it in the stamped reply envelope. Your answers are very important to us. Please feel free to elaborate on the answers by using the reverse side of the pages of the questionnaire.

Of course, your answers will be kept confidential and will be used only in combination with others to get a composite picture.

Thank you for your valuable assistance.

Sincerely,

P. S. Bhullar

SURVEY OF LEADING SCIENTISTS IN THE OPTICAL FIELD IN INDIA

1. What is your field of specialization?

   Physics _____

   Optics _____

   Engineering _____

   Other (please specify) _____

2. Which of the following job descriptions best describe your job function?

   Basic Research _____

   Applied Research _____

   Engineer _____

   Optical Design _____

   Consultant _____

   Manager _____

   Other (please specify) _____

3. Do you personally specify the following items?

	YES	NO	If YES, please indicate approx. purchases in 1973
Optical Components	___	___	Rs. _____
Optical Systems	___	___	Rs. _____
Optical Instruments	___	___	Rs. _____
Electro Optical Instruments	___	___	Rs. _____
Electrical Accessories for Optical Instruments	___	___	Rs. _____

OPTICAL COMPONENTS:

1. Please estimate the percentage of your current budget for optical components, i.e., lenses, mirrors, etc., that will be spent on imported components. Also, please estimate a similar percentage for 1980.

	Current	1980
0 - 10%	_____	_____
11 - 20%	_____	_____
21 - 30%	_____	_____
31 - 40%	_____	_____
41 - 50%	_____	_____
Over 50%	_____	_____

2. Does your organization have its own optical shop (or has easy access to an optical shop) for the manufacture of custom optical components?

Yes _____ No _____

If the answer is yes, then please briefly describe the functions and capacity of this shop.

_____

_____

_____

_____

3. What is your estimate of the relative consumption of optical components in India?

Government:	Research Institutes	_____ %
	Defense	_____ %
	Other	_____ %
Educational Institutions		_____ %
Private Research Institutions		_____ %
Industry:	Instrument Manufacturers	_____ %
	Other	_____ %
	Total	100 %

4. Listed below are some of the problems that you might be facing in procuring optical components from Indian manufacturers. Please rate the significance of each of these problems for a particular component, putting a rating of 1 to 5 in the appropriate box below. A rating of 5 means that the problem is very significant, and it prevents you from buying the component from Indian manufacturers, whereas a rating of 1 means that the problem is essentially nonexistent. Ratings of 2, 3 and 4 describes the problem as being in between the two extremes just mentioned.

	Limited Variety of Glass Available In India	Poor Optical Qualities of the Glass	Wide Variation in Manufacturing Tolerances & Poor Quality Control	Limited Types of Optical Coatings Available	Long Delivery Times	Other Problems (Please Specify)	Comments
Optical Flats	☐	☐	☐	☐	☐	_____	_____
Mirrors	☐	☐	☐	☐	☐	_____	_____
Lenses-Precision 2 rings or better)	☐	☐	☐	☐	☐	_____	_____
Lenses-Ordinary	☐	☐	☐	☐	☐	_____	_____
Prisms	☐	☐	☐	☐	☐	_____	_____
Diffraction Gratings		☐	☐		☐	_____	_____
Fiber Optics		☐	☐		☐	_____	_____

OPTICAL AND ELECTRO-OPTICAL INSTRUMENTS:

1. Please estimate the percentage of your current budget for optical and electro-optical instruments that will be spent on instruments that are imported into India. Also, please estimate a similar percentage for 1980.

	Current	1980
0 - 20%	_____	_____
21 - 40%	_____	_____
41 - 60%	_____	_____
61 - 80%	_____	_____
81 - 100%	_____	_____

2. What is your estimate of the relative consumption of optical and electro-optical instruments in India?

Government:	Research Institutes	_____%
	Defense	_____%
	Other	_____%
Educational Institutions		_____%
Private Research Institutions		_____%
Industry		_____%
	Total	100 %

3. On a scale of 1 to 5 please rate a typical sample of each class of optical instruments manufactured in India with similar instruments that are imported into India, using the criteria in the table on the next page.

(A rating of)	1	(means that the typical instrument manufactured in India is)	greatly inferior	(to similar imported instruments)	
(")	2	(")	moderately inferior	(")	
(")	3	(")	equivalent	(")	
(")	4	(")	moderately superior	(")	
(")	5	(")	greatly superior	(")	

OPTICAL INSTRUMENTS	Resolution	Range	Reliability	Availability	Price	Comments
Microscopes:						
General Purpose	☐	☐	☐	☐	☐	
Precision	☐	☐	☐	☐	☐	
Telescopes	☐	☐	☐	☐	☐	
Photometers	☐	☐	☐	☐	☐	
Spectrophotometers	☐	☐	☐	☐	☐	
Radiometers	☐	☐	☐	☐	☐	
Spectroradiometers	☐	☐	☐	☐	☐	
Colorimeters	☐	☐	☐	☐	☐	
Microdensitometers	☐	☐	☐	☐	☐	
Interferometers:						
Twyman Green	☐	☐	☐	☐	☐	
Michelson	☐	☐	☐	☐	☐	
Refractometers	☐	☐	☐	☐	☐	
Polarimeters	☐	☐	☐	☐	☐	
Image Intensifiers	☐	☐	☐	☐	☐	
Infrared Viewers	☐	☐	☐	☐	☐	
MTF Measuring Equip.	☐	☐	☐	☐	☐	
Other: (Please Specify)						
_____	☐	☐	☐	☐	☐	
_____	☐	☐	☐	☐	☐	

4. Which optical and electro-optical instruments do you think are in greatest demand in India but are not yet being produced in India in sufficient quantity?

Description of Instrument	Your Estimate of Annual Demand	Comments
_____	_____ units	_____
_____	_____ units	_____
_____	_____ units	_____
_____	_____ units	_____

GENERAL:

Please describe in as much detail as you can the current status and the future potential as you see it, for the optical industry in India.

Thank you for your cooperation.

APPENDIX B

THE USE OF A CAUSAL MODEL TO FORECAST THE OPTICAL GOODS MARKET IN INDIA

Optical Components

The four causal factors that together make up the market for optical goods in India were described in Chapter VII. Thus, the total sales of optical components S_1 in 1973 may be represented as:

$$S_1 = R_1 + D_1 + E_1 + I_1 \qquad - - - (1)$$

where R_1 = Sales of Optical Components to Scientific Research Organizations in 1973

D_1 = Sales of Optical Components to the Department of Defense in 1973

E_1 = Sales of Optical Components to Educational Institutions in 1973

I_1 = Sales of Optical Components to Manufacturing Industries in 1973

From Exhibit 11 we find that the sales of optical components to Scientific Research Organizations (Government 14.4% and Private 11.2%) is 25.6% of the total sales of optical components in 1973. Therefore, the relationship between R_1 and S_1 is:

$$R_1 = 0.256\ S_1$$

Similarly, the relationships between D_1, E_1, I_1 and S_1 may be obtained from Exhibit 11.

$$D_1 = (0.313 + 0.062)\ S_1 = 0.375\ S_1$$
$$E_1 = 0.125\ S_1$$
$$I_1 = (0.223 + 0.021)\ S_1 = 0.244\ S_1$$

If we assume that the causal factors remain unchanged between 1973 and 1980, we may represent the total sales of optical components S_2 in 1980 as:

$$S_2 = R_2 + D_2 + E_2 + I_2 \qquad - - - (2)$$

where R_2, D_2, E_2 and I_2 are the 1980 sales of optical components to Scientific Research Organizations, The Department of Defense, Educational Institutions and Manufacturing Industry, respectively.

Let R_2 represent a% of S_2, the total optical component sales in 1980.

$$\text{i.e., } R_2 = a\ S_2$$

Similarly, let us define three other variables b, c and d such that:

$$D_2 = b\ S_2$$

$$E_2 = c\ S_2$$

$$I_2 = d\ S_2$$

On substituting these new values for R_2, D_2, E_2 and I_2 in Equation (2) we get:

$$S_2 = a\ S_2 + b\ S_2 + c\ S_2 + d\ S_2$$

or

$$a + b + c + d = 1 \qquad \text{- - - (3)}$$

From Exhibit 4 we see that the average annual expenditure for scientific research is expected to increase from Rs 0.677 billion in 1973 to about Rs 1.4 billion in 1980. This is equivalent to a compounded annual growth rate of 10.9%. We assume that the ~~rate~~ increase ~~of~~ in sales of optical components to scientific research organizations will match this rate. Then:

$$R_2 = \frac{1.4}{0.677}\ R_1 = 2.07\ R_1$$

or $$a\ S_2 = 2.07 \times 0.256 \times S_1$$

or $$K = \frac{S_2}{S_1} = \frac{2.07 \times 0.256}{a} = \frac{0.53}{a} \qquad \text{- - - (4)}$$

where K is the ratio of total sales of optical components in 1980 to the total sales of optical components in 1973.

The capital expenditures for defense in 1973 and 1980 can be calculated from the regression line in Exhibit 5 if we assume that the same regression line will be valid in 1980. The capital expenditures for defense in 1973 and 1980 are Rs 2.08 billion and Rs 3.48 billion. Again, assuming that increase in sales of optical components to the Department of Defense will match this rate of increase, we have:

$$D_2 = \frac{3.48}{2.08} D_1 = 1.67\ D_1$$

or $$b\ S_2 = 1.67 \times 0.375\ S_1$$

or $$K = \frac{S_2}{S_1} = \frac{1.67 \times 0.375}{b} = \frac{0.63}{b} \qquad \text{- - - (5)}$$

In a similar fashion and using the same arguments we get:

$$E_2 = \frac{1.55}{1.025} E_1 = 1.51\ E_1$$

or $$c\ S_2 = 1.51 \times 0.125\ S_1$$

or $$K = \frac{S_2}{S_1} = \frac{1.51 \times 0.125}{c} = \frac{0.19}{c} \qquad \text{- - (6)}$$

also

$$I_2 = \frac{264.74}{206.1} I_1 = 1.28\ I_1$$

or $$d\ S_2 = 1.28 \times 0.244\ S_1$$

or $$K = \frac{S_2}{S_1} = \frac{1.28 \times 0.244}{d} = \frac{0.31}{d} \qquad - - - (7)$$

From equation (3) we know that:

$$a + b + c + d = 1$$

Substituting for a, b, c and d from equations 4, 5, 6 and 7, respectively, we get:

$$\frac{0.53}{K} + \frac{0.63}{K} + \frac{0.19}{K} + \frac{0.31}{K} = 1$$

or $$K = \frac{S_2}{S_1} = 0.53 + 0.63 + 0.19 + 0.31 = 1.66$$

Therefore, the ratio of total estimated sales of optical components in 1980 to the total sales of optical components in 1973 is 1.66. This is equivalent to a compounded annual growth rate of 7.5%.

Optical Instruments

Employing the same four causal factors discussed earlier, we can use the following equations to represent S_3 and S_4, i.e., the total sales of optical instruments in 1973 and 1980, respectively.

$$S_3 = R_3 + D_3 + E_3 + I_3 \qquad - - - (8)$$

and

$$S_4 = R_4 + D_4 + E_4 + I_4 \qquad - - - (9)$$

where the symbols R_3, D_3, E_3 and I_3 are the sales of optical instruments to each of the four market segments in 1973 and R_4, D_4, E_4 and I_4 are the sales of optical instruments to the same market segments in 1980.

From Exhibit 12 we obtain the following relationships:

$$R_3 = (0.222 + 0.109)\ S_3 = 0.331\ S_3$$

$$D_3 = (0.339 + 0.039)\ S_3 = 0.378\ S_3$$

$$E_3 = 0.161\ S_3$$

$$I_3 = 0.130\ S_3$$

Let us define four variables a_1, b_1, c_1 and d_1 such that:

$$R_4 = a_1\ S_4$$

$$D_4 = b_1\ S_4$$

$$E_4 = c_1\ S_4$$

$$I_4 = d_1\ S_4$$

and $$a_1 + b_1 + c_1 + d_1 = 1 \qquad \text{- - - (10)}$$

Since the market segments and their growth rates are the same for optical instruments as those for optical components, the following set of equations, which are similar to those already obtained for optical components, may be written.

$$R_4 = 2.07\ R_3$$
$$D_4 = 1.67\ D_3$$
$$E_4 = 1.51\ E_3$$
$$I_4 = 1.28\ I_3$$

Upon rewriting these equations in terms of the variables S_3 and S_4, we obtain the following set of equations:

$$K_1 = \frac{S_4}{S_3} = \frac{2.07 \times 0.331}{a_1} = \frac{0.69}{a_1}$$

$$K_1 = \frac{S_4}{S_3} = \frac{1.67 \times 0.378}{b_1} = \frac{0.63}{b_1}$$

$$K_1 = \frac{S_4}{S_3} = \frac{1.51 \times 0.161}{c_1} = \frac{0.24}{c_1}$$

$$K_1 = \frac{S_4}{S_3} = \frac{1.28 \times 0.130}{d_1} = \frac{0.17}{d_1}$$

Substituting for a_1, b_1, c_1 and d_1 in equation (10) we get:

$$\frac{0.69}{K_1} + \frac{0.63}{K_1} + \frac{0.24}{K_1} + \frac{0.17}{K_1} = 1$$

or $$K_1 = \frac{S_4}{S_3} = 1.73$$

Therefore, the ratio of total estimated sales of optical instruments in 1980 to the total sales of optical instruments in 1973 is 1.73. This is equivalent to a compounded annual growth rate of 8.1%.