

C3

CATALOGUE No.

13-524

OCCASIONAL



INDUSTRIAL RESEARCH AND DEVELOPMENT  
EXPENDITURES IN CANADA  
1963

Fifth survey in this series. The 1955 survey was published as Reference Paper No. 75; the 1957, 1959 and 1961 surveys as DBS Catalogue numbers 13-509, 13-516 and 13-520.

LIBRARY  
POOR CONSULTATION

DOMINION BUREAU OF STATISTICS

CATALOGUE NO.

13-524

OCCASIONAL

ERRATA

Industrial Research and Development Expenditures in Canada

1963

Page	Table		Column	Delete	Substitute
13	1	Heading	First	4 & \$	R & D
	2	Food and beverages	1961	2,591,489	2,591,487
17	8	Rubber	Physics	-	172,274
18	9	Other non-manu- facturing	Newsprint	269,120	296,120
		Electrical products	Rolling, casting and extruding	-	433
19		Machinery	Petrochemicals	17,955	1,205
		Transportation equipment	Petrochemicals	-	17,955
20		Totals	Scientific and professional equipment	4,092,137	4,112,137
23	14	Rubber	Chemical engineers	2	13

DOMINION BUREAU OF STATISTICS

Business Finance Division  
Planning and Development Section

INDUSTRIAL RESEARCH AND DEVELOPMENT  
EXPENDITURES IN CANADA

1963

*Published by Authority of*  
The Minister of Trade and Commerce

November 1965  
6602-513

Price: 75 cents

ROGER DUHAMEL, F.R.S.C., Queen's Printer and Controller of Stationery, Ottawa

## PRÉFACE

Since its establishment, one of the main objectives of the National Research Council has been to encourage Canadian industry to undertake research. To provide itself, and other interested groups, with an accurate representation of the state of industrial research in Canada, the Council requested the Dominion Bureau of Statistics to survey Canadian firms. The first survey of industrial research and development was made in 1955, and has been repeated biennially since then. This publication contains the results of the fifth such survey conducted by the Bureau of Statistics in cooperation with the National Research Council. It presents an estimate of the magnitude and direction of the research and development programme undertaken by Canadian industry in 1963 and provides an indication of the relative size of the 1964 expenditures.

The 1963 survey sought information on the cost of research and development conducted by Canadian firms, the sources of these funds, and the expenditures on purchases of research results from others. It also requested data on the principal fields of science and areas of research, the industrial product groups in which the work was carried out, and on the personnel employed in research and development.

The assistance of the many business firms who have cooperated with us by submitting reports is gratefully acknowledged.

WALTER E. DUFFETT,

October, 1965.

*Dominion Statistician*

## TABLE OF CONTENTS

	Page
Definitions .....	6
The Industrial Research and Development Survey .....	9
<b>SECTION I</b>	
General Review .....	11
<b>SECTION II</b>	
Statistical Tables	
1. Current R & D Expenditures in Canada, by Industry, 1961 and 1963 .....	13
2. Intra-mural R & D Expenditures, by Industry, 1959-64 .....	13
3. Canadian Sources of Funds for Intra-mural R & D, by Industry, 1963 .....	14
4. Foreign Sources of Funds for Intra-mural R & D, by Industry, 1963 .....	14
5. Canadian Extra-mural Payments, by Industry and Recipient of Payment, 1963 .....	15
6. Foreign Extra-mural Payments, by Industry and Recipient of Payment, 1963 .....	15
7. Payments Made and Received by the Reporting Company for Patents, Licences and Technical "Know-how" Embodying the Results of Research, by Industry, 1963 .....	16
8. Intra-mural R & D Expenditures, by Industry and Field of Research, 1963 .....	16
9. Intra-mural R & D Expenditures, by Industry and Product Group, 1963 .....	18
10. Intra-mural R & D Expenditures, by Industry and Area of Research, 1963 .....	20
11. Intra-mural R & D Expenditures, by Industry and Type of Research-development, 1963 .....	21
12. Capital Expenditures on New or Extended Facilities for Use in R & D Activities, 1961-64 .....	22
13. Personnel Engaged in R & D, by Industry and Class, 1963 .....	22
14. Professional Personnel Engaged in R & D, by Industry and Field of Training, 1963 .....	23
15. Professional Personnel Engaged in R & D, by Industry and Type of Research- development, 1963 .....	24
16. Number of Canadian Firms Reporting R & D Expenditures, by Industry, 1963 .....	24
17. Year of Establishment of a Permanent Unit for R & D, by Industry .....	25
18. Dollars Spent on Canadian R&D in 1963 per One Hundred Dollars of Sales, by Industry .....	25
<b>SECTION III</b>	
Questionnaires .....	26

## DEFINITIONS

1. The following definition of research and development was used in the 1963 survey:

- (a) Scientific R & D is investigative work carried out:
- (1) to acquire new knowledge,
  - (2) to devise and develop new products or processes, or
  - (3) to apply newly acquired knowledge in making improvements to existing products or processes.

When necessary to test a new or improved product or process, the design, construction and evaluation of a pilot plant or prototype are included in scientific R & D.

- (b) Scientific R & D does NOT include:
- (1) research in the social or psychological sciences,
  - (2) market research,
  - (3) operations research (except when the design of mechanical systems is involved),
  - (4) sales promotion,
  - (5) quality control of products or materials or routine product testing,
  - (6) prospecting, exploring or drilling for minerals, petroleum or natural gas, including geological, geo-physical or related studies,
  - (7) preparation of specifications and other engineering information required to enable construction of facilities for commercial production,
  - (8) preparation, prior to commencement of commercial production, of instructions for the operation of facilities referred to in paragraph (7).
- (c) It is important to distinguish between development and production. Development ceases and production begins when the work or process becomes routine and is no longer experimental. For example, a pilot plant, once the original, investigative work is over, may be used as a production unit. Its operating costs may then no longer be considered development costs. Similarly, a research unit may spend a portion of its time on quality control or routine testing of raw materials. The effort devoted to such non-research activities cannot be attributed to R & D.

2. In this report the following terminology is used:

- (a) Canadian firm—a firm operating in Canada. As a rule, any foreign branches or affiliates are excluded.
- (b) Canadian R & D expenditures—expenditures of such firms in Canada, *i.e.* within their Canadian organization or by means of payments to other Canadian firms or institutions.
- (c) Reporting company—the organization which submitted the return. In the case of a consolidated return, "reporting company" could include several firms.
- (d) Intra-mural expenditures—expenditures for work performed within the reporting company.
- (e) Extra-mural expenditures—expenditures for work performed outside the reporting company, *i.e.* payments for the R & D performed by other firms and organizations for the reporting company.

3. The industries included in the survey are defined as follows:

### **Mines, quarries and oil wells**

Companies primarily engaged in both mineral and non-mineral mining, the extraction of mineral fuels, the operation of quarries and sand pits, or the provision of certain services to these operations.

### **Food and beverages**

Companies primarily engaged in processing foods and beverages for consumption.

### **Tobacco products**

Companies primarily engaged in processing tobacco and manufacturing cigars and cigarettes.

### **Rubber**

Companies primarily engaged in manufacturing all kinds of natural or synthetic rubber products.

### **Leather**

Companies primarily engaged in tanning, curing and finishing hides and skins, and in manufacturing all kinds of products made principally of leather.

### **Textiles**

Companies primarily engaged in preparing thread, yarn or fabrics made of cotton, wool or synthetic materials; in the processing of fibres and felt; in the manufacture of cordage, carpets, cloth bags and coated fabrics such as linoleum; and in the dyeing and finishing of fabrics.

### **Knitting mills**

Mills which knit, dye or finish knitted goods such as hosiery and underwear.

### **Clothing**

Companies primarily engaged in the manufacture of clothing, including clothing for men, women and children, fur goods, hats and caps, and foundation garments.

## DEFINITIONS — Concluded

### **Wood**

Companies primarily engaged in producing lumber and wood basic materials, and manufacturing finished articles made entirely or mainly of wood.

### **Furniture and fixtures**

Companies primarily engaged in the manufacture of furniture and fixtures for the household, office or school, regardless of the materials used.

### **Paper and allied industries**

Companies primarily engaged in the manufacture of pulp either from wood or other fibres, conversion of these pulps into any kind of paper or paper board, or the manufacture of paper and paper board into converted products.

### **Primary metal**

Includes iron and steel mills, steel pipe and tube mills, iron foundries, and companies primarily engaged in smelting and refining ores, or in rolling, casting and extruding metals.

### **Metal fabricating**

Companies primarily engaged in fabricating structural steels; in stamping, pressing and coating sheet metal; in manufacturing ornamental metal products, wire and wire products, hardware, tools and cutlery, and heating equipment. Machine shops, boiler and plate works are also included.

### **Machinery**

Companies primarily engaged in manufacturing agricultural implements, commercial refrigeration and air conditioning equipment, office and store machinery, and machinery and equipment used for construction, mining, processing and manufacturing.

### **Transportation equipment**

Companies primarily engaged in manufacturing or assembling aircraft and parts, motor vehicles, railroad rolling stock, ships and boats, or in the repair of all of the above items except motor vehicles.

### **Electrical products**

Companies primarily engaged in the manufacture of electrical machinery and appliances, communication equipment, and other electrical products such as electric wires, batteries, fixtures, computers and data processors.

### **Non-metallic mineral products**

Companies primarily engaged in the manufacture of articles made entirely or mainly of non-metallic minerals such as cement, asbestos, clay, glass, stone and concrete, or in the preparation of such materials.

### **Petroleum and coal products**

Companies primarily engaged in refining crude petroleum, and in manufacturing petroleum and coal products.

### **Chemical and chemical products**

Companies primarily engaged in manufacturing industrial chemicals, medicinal and pharmaceutical preparations, soaps and washing compounds, paints and varnishes, and miscellaneous chemicals including fertilizers, sweeping compounds, adhesives, polishes and dressings.

### **Miscellaneous manufacturing**

Companies primarily engaged in manufacturing scientific and professional equipment, plastic goods, sporting goods, musical instruments and any other manufactured products not covered elsewhere.

### **Construction**

Contractors engaged in the construction of buildings, highways, bridges and utilities.

### **Transportation, storage, communication and other utilities**

Companies primarily engaged in the operation of air, land or water transportation services, in the storage of grain and other commodities, in the operation and maintenance of communication systems, or in providing utilities such as electric power, gas, water and steam.

### **Service**

Establishments primarily engaged in providing engineering and scientific services, including research laboratories and aerial survey operations. Trade and industrial association are also included.

## THE INDUSTRIAL RESEARCH AND DEVELOPMENT SURVEY

### General

The role of scientific research and development as a determinant of the growth of the economy and, for that matter, of the individual firm, is imperfectly understood. To determine more precisely the role of R & D in such economic growth, more and improved statistics are required. The purpose of the Dominion Bureau of Statistics' survey of industrial research and development is to provide at least some of the necessary data.

The value of R & D statistics is continually increasing as more detailed and more accurate information becomes available for a longer period of time. Users include persons in government, industry and the universities. Uses range from providing a base for forecasts of research trends and the employment of scientific manpower, to the comparison made by a firm between aspects of its R & D programme and the data published for its industry.

The DBS has surveyed Canadian industrial R & D biennially since 1955. The present publication is the fifth in this series.<sup>1</sup> During these eight years the number of companies reporting making payments for R & D has increased from 377 to 701, while total reported current expenditures have increased from \$60 million to \$201 million.

Generally speaking, only firms of at least a certain size, which will depend, in part, on the type of product or service provided, would be involved in research and development. Using a criterion such as employment it is possible to maintain a basic list of firms to be surveyed. This list is supplemented by information from various sources such as trade journals and the public accounts of governments indicating that firms are engaged in R & D. The survey is not a census in the usual sense of the term, nor is it what may be termed a sample survey; it is rather a survey of all firms known to be financially supporting R & D, or which have the potential ability to perform such activities. The results of the surveys are summations of the reported figures, including estimates for any major non-respondents, and no allowance is made for

<sup>1</sup> Reference Paper No. 75 (1955), DBS Catalogue Nos. 13-509 (1957), 13-516 (1959) and 13-520 (1961).

firms not included in the coverage. It is believed that owing to the concentration of R & D activities among a small number of enterprises, the expenditures of firms not covered would not greatly alter the reported totals.

The survey is conducted entirely by mail. Ideally, of course, a mail survey followed or complemented by personal interviews would be the best method of collecting the data and ensuring that a common interpretation of terms was being used. However, the resources required for this procedure are not available.

Not all industries are included in the survey. It was felt that some, because of the nature of their activities or because of the composition of the industry, would not be involved in research and development to any substantial degree. These industries are: Agriculture, Forestry, Fishing and Trapping, Printing and Publishing, Trade, Finance, Insurance, Real Estate, the Community, Business and Personal Industries (except for the Engineering and Scientific Services and Trade Associations). Non-profit and educational institutions are not covered in this survey, but would provide the subjects for separate surveys. The Federal Government is covered in the biennial survey "Federal Government Expenditures on Scientific Activities".

The reporting unit is generally the company. This unit has been used in this survey since a company, although it may have several establishments or even subsidiaries, will often have a centralized research unit. In the case of a company with decentralized research units, the reporting unit may be the division, if the accounting system enables divisions to supply the required data. This procedure creates the problem of the blurring of industrial classifications. Although a company, because of its divisions or subsidiaries, is involved in several industrial fields, it can be assigned to only one industry. The criterion would be the industrial classification which would include the greatest value of its product. Thus comparisons between such industries and those built up from establishment reporting units may not be justified.

### The 1963 Survey

The coverage of the 1963 survey was greater than in any other year. In all, approximately 3,300 firms were contacted. A one page questionnaire was sent to 2,400 companies. This questionnaire is reproduced on page 26. Those firms indicating that they were paying for R & D were then included in

the main survey. The response rate to this preliminary survey was 97.5%. About 1,400 companies were contacted in the main survey. The forms used are reproduced on pages 27-36. For this part of the survey the response rate was 92.9%.



Several new questions were included in the questionnaires. This was necessary in order to provide the additional information now required by the users of Canadian R & D statistics. Questions 5, 8, 9 and 12 are entirely new, while other questions were modified to provide more detail. So far as possible, the questionnaires are in accordance with the recommendations of the OECD manual "Proposed Standard Practice for Surveys of Research and Development". This will eventually make possible international comparisons.

The annex to the main questionnaire was primarily designed both to obtain the names of firms involved in R & D but not included in the original

mailing list, and to ensure that firms' subsidiaries were not overlooked. The remaining questions were intended to provide some information on the general background to Canadian R & D and on industry's research policies.

Because of the income tax incentives and other government policies favouring industrial research, many firms have re-examined their accounting procedures and their interpretation of the definitions for R & D. This has led, in some cases, to revisions of their previously reported expenditures for 1961 and 1962. Hence comparisons of the data from earlier surveys with those from the present survey should be made with caution.

## SECTION I

### General Review

In this latest survey of industrial R & D in Canada, 701 firms reported that they performed or financed R & D. This is an apparent increase of 178 companies, or 34% since 1961. However, an increase in the number of enterprises reporting R & D expenditures does not imply a directly related increase in such expenditures, since only part of the increase in number is due to the initiation of R & D programmes by companies. For example, if a firm which has submitted consolidated returns in the past now requires its subsidiaries to make their

own reports, this would increase the number of firms shown as engaged in R & D. Similarly, more complete coverage of Canadian industry results in the inclusion for the first time of several smaller firms every year, although they may actually have been involved in research and development in previous survey years. It may be assumed, however, that a real increase of considerable size has, in fact, occurred. One indication of this is the data of Table 17, which show that 40% of all Canadian R & D units were established between 1960 and 1964.

Summary of Current R & D Expenditures of Canadian Firms, 1955 - 63

Year	Canadian R & D				Payments for R & D done outside Canada	Total R & D expenditures	Total number of firms reporting R & D expenditures
	Firms reporting expenditures in Canada	Intra-mural expenditures	Extra-mural expenditures	Total expenditures			
millions of dollars							
1955 .....	..	51.4	1.9 <sup>1</sup>	53.3 <sup>1</sup>	12.2	65.5	377
1957 .....	..	124.5	4.2	128.7	19.8	148.5	455
1959 .....	432	96.6	3.3	99.9	21.7	121.6	471
1961 .....	464	114.0 <sup>2</sup>	4.3	115.9 <sup>2 3</sup>	31.2	147.1	523
1963 .....	650	160.2	8.0	163.4 <sup>3</sup>	37.8	201.2	701

<sup>1</sup> Grants in aid of research are not included.

<sup>2</sup> Revised.

<sup>3</sup> To avoid double-counting, certain payments, which are extra-mural for one respondent and intra-mural for another, have been subtracted from the sum of all Canadian intra- and extra-mural expenditures.

.. Figures not available.

Surveyed firms reported total current expenditures of \$201.2 million for 1963 — an increase of almost 37% over 1961. Further substantial increases are indicated for 1964, respondents estimating that 1964 R & D expenditures would total approximately \$228.5 million.

The bulk of research and development continues to be concentrated in a few large firms. As in 1961,

16 firms accounted for 50% of total intra-mural expenditures. There is also a concentration of R & D expenditures within the industry classifications. In 1963, three industries (the transportation equipment, electrical products and chemical and chemical products industries) reported expenditures in Canada which amounted to 55% of the total. The concentration in 1961 was slightly higher (57%), but it is impossible to say if there is a downward trend or not.

**Total Current R & D Expenditures in Canada, 1961 and 1963**

Industry	1961 <sup>1</sup>		1963	
	Amount	Per cent	Amount	Per cent
	\$'000,000	%	\$'000,000	%
Electrical products .....	28.2	24.3	33.4	20.4
Transportation equipment.....	17.4	15.0	31.2	19.1
Chemical and chemical products .....	20.3	17.5	25.0	15.3
Primary metals .....	7.2	6.2	10.7	6.5
Paper and allied industries .....	6.6	5.7	9.2	5.6
Petroleum and coal products .....	5.6	4.8	7.6	4.7
Mines, quarries and oil wells .....	5.2	4.5	7.6	4.7
Machinery .....	5.4	4.7	7.2	4.4
Other industries .....	20.0	17.3	31.5	19.3
<b>Totals .....</b>	<b>115.9</b>	<b>100.0</b>	<b>163.4</b>	<b>100.0</b>

<sup>1</sup> Revised

Compared to 1961 expenditures, the relative increases reported by most industries were quite large. The payments made by all industries increased 41%, three of the industries shown in the table above having relative increases exceeding this figure (transportation equipment 80%, primary

metals 49% and mines, quarries and oil wells 46%). The increased research and development activity in the transportation equipment industry is due, to a great extent, to government expenditures in the Canadian space investigation programme.

**Sources of Funds for Intra-mural R & D in 1963**

Source	Canadian sources		Foreign sources	
	Amount	Per cent	Amount	Per cent
	\$'000,000	%	\$'000,000	%
Reporting company .....	118.3	77.5	—	0.4
Parent, affiliated and subsidiary companies....	2.6	1.7	4.5	59.9
Government funds through:				
(a) Prime contracts .....	22.1	14.4		
(b) Procurement contracts .....	3.0	2.0		
(c) Grants in aid of R & D .....	3.1	2.0		
Contract work for other companies .....	1.7	1.1	1.1	14.9
Others .....	1.9	1.3	1.8 <sup>1</sup>	24.8
<b>Totals .....</b>	<b>152.7</b>	<b>100.0</b>	<b>7.4</b>	<b>100.0</b>

<sup>1</sup> Includes payments from foreign governments.

Over 95% of the funds for R & D come from Canadian sources, of which the most important is the reporting company itself. Since 1957, when data on source of funds were first available, the proportion of R & D activity financed by the performers has increased considerably — from 39.1% of funds from all sources in 1957 to 77.5% of funds from Canadian sources in 1963. Five industries provide over 95% of the funds required for their R & D programmes. An important source of funds remains the Federal Government, although its support varies from industry to industry. Two industries receive over 80% of such support: almost 49% goes to the transportation equipment industry and 33% to the electrical products industry. Most of this support is for projects in the fields of defence, nuclear energy and space research.

At present there are three Federal Government programmes of direct financial assistance designed to encourage industrial R & D. The two intended to

support industrial research are administered by the National Research Council (Industrial Research Assistance Programme) and by the Defence Research Board (Defence Industrial Research Programme). In both these programmes the Government is prepared to pay roughly 50% of the costs of approved research projects. Such grants totalled \$4.2 million during the 1963-64 fiscal year. The third programme, administered by the Department of Industry, is intended to assist Canadian companies to maintain and improve their technological capabilities in order to meet the requirements for United States defence contracts. During the 1963-64 fiscal year \$19 million was spent by the Government in the Defence Assistance Programme. In June 1965 a fourth plan, the Programme for the Advancement of Industrial Technology, was announced. It will provide financial assistance for specific technical development projects and will also be administered by the Department of Industry.

Other government departments or agencies supplement their own R & D programmes by awarding contracts to individual firms. Atomic Energy of Canada Limited and the Armed Forces are the most important of these sponsors.

Canadian industry pays more for research performed abroad, or the results of such research, than it receives. Foreign support of Canadian research amounted to \$7.4 million, whereas Canadian firms reported payments for foreign research totalling \$37.8 million. In 1963, surveyed companies received \$2.3 million from abroad for patents, licences and technical "know-how". These companies paid \$21.1

million to foreign sources for such research results. This latter figure can only be a portion of such payments made by all Canadian firms. It is at present, however, impossible to estimate the value of the information or new techniques resulting from research which are communicated from abroad at little or no cost to the recipients. Hence it would be incorrect to rely solely on the above figures when considering the research relations between Canadian and foreign industry.<sup>2</sup>

<sup>2</sup> An interesting study of one aspect of this problem is presented in "Policies and Practices of United States Subsidiaries in Canada" by John Lindeman and Donald Armstrong, Canadian-American Committee, 1960, pp. 57-64.

### Intra-mural R & D Expenditures, by Product Group, 1963

Recipient product group <sup>1</sup>	Amount	Per cent
	\$'000,000	%
Electronic equipment .....	27.2	17.0
Aircraft and parts .....	26.7	16.7
Chemicals (except drugs and medicines) .....	13.0	8.0
Smelting and refining .....	10.5	6.5
Electrical products (except electronic equipment) .....	9.4	5.9
Machinery .....	8.3	5.2
Paper products .....	7.5	4.6
Petroleum and coal products .....	6.5	4.1
Textiles .....	5.8	3.6
Food and beverages .....	4.6	2.9
Drugs and medicines .....	4.1	2.6
Scientific and professional equipment .....	4.1	2.6
Motor vehicles and parts .....	2.9	1.8
Rubber products .....	2.8	1.8
Mining .....	2.5	1.6
Rolling, casting and extruding .....	2.4	1.5
Other .....	21.9	13.6
Totals .....	160.2	100.0

<sup>1</sup> Definitions of some of the product groups are on page 32.

Although the classifications of product groups are perhaps not clearly defined, the above table gives an idea of the general directions of research. The first three product groups accounted for almost 42% of total intra-mural R & D expenditures. Most industries reported working in these areas. The widest range of product groups was covered by the research and development of the chemical and machinery industries.

For the first time, figures on expenditures and manpower in the three types of research-development are available. As was assumed before, development receives the bulk of all industrial R & D effort — almost 72% of expenditures and 69% of professional personnel. Applied research absorbs 23% of expenditures and 24% of professionals. Only 5% of expenditures and a little less than 7% of professionals were devoted to basic research.<sup>3</sup> Since the division of activities into these three areas is extremely difficult and since neither the DBS nor many of the survey respondents have had previous experience in this type of classification, no attempt is made to comment on the reported figures, which should be used with caution.

<sup>3</sup> The terms basic research, applied research and development are defined on page 30.

Approximately 3% of intra-mural expenditures were reported to be made for R & D in the area of nuclear energy. The electrical products industry accounted for almost 60% of such expenditures. Research and development in the area of space travel and communications was responsible for almost 7% of total intra-mural expenditures. The major performer was the transportation equipment industry (79%). The costs of R & D for defence purposes were slightly over 16% of the total, with the electrical products and transportation equipment industries reporting almost 83% of these expenditures.

Capital expenditures for new or extended R & D facilities have shown a tremendous increase in the last two years of the period 1961-1964. The average of the capital expenditures in 1963 and 1964 was \$31 million, 146% greater than the average of the 1961 and 1962 expenditures. This increase in facilities may be an indication of a higher level of R & D activity in the future. The industries with the largest capital expenditures were electrical products, chemical products, primary metals, petroleum, mines and paper products.

The reporting of R & D personnel is often difficult, especially in the treatment of part-time personnel. It has also been hard to achieve a standard treatment for the classification of workers by discipline or function, especially in the case of administrators. The detail of Table 14 should, therefore, be used with caution. In 1963, the surveyed companies reported employing the equivalent of 5,795 scientists and engineers in R & D, supported by 8,364 non-professional workers. They also estimated that about 6,300 professionals would be required in 1964. An examination of the data for the period 1957-63 reveals that about 60% of all professionals are engineers, and that approximately 12% of all professionals have doctorates. The overall ratio of supporting personnel to professionals appears to be

about 1.5. The current expenditures per professional seem to be increasing, the 1963 data giving a figure of \$27,000.

In the last survey, firms were asked to give the year in which they first established a permanent unit for research and development. An increasing participation in industrial R & D is apparent from their replies. Only 7.6% of such units were formed before 1930 and 19.5% from 1930-1949. During the decade 1950-59, 32.8% of the units were established, but the five years 1960-64 alone accounted for 40.1% of all R & D units. In other words, almost three quarters of the units were established in the last 15 years, more than half of these during the last five years.

SECTION II

TABLE 1. Current R & D Expenditures in Canada, by Industry, 1961 and 1963

Industry	1961			1963		
	Intra-mural 4 & \$ expenditures <sup>1</sup>	Canadian extra-mural payments <sup>2</sup>	Net industrial P & D expenditures <sup>3</sup>	Intra-mural R & D expenditures	Canadian extra-mural payments	Net industrial R & D expenditures <sup>3</sup>
	dollars					
Mines, quarries and oil wells .....	4,820,816	505,082	5,157,494	6,560,188	1,432,273	7,608,918
Manufacturing:						
Food and beverages .....	2,591,487	109,549	2,686,036	4,299,244	423,553	4,545,622
Rubber .....	1,425,008	2,500	1,427,508	1,873,549	1,500	1,875,049
Textile .....	1,487,152	96,474	1,558,726	1,875,104	160,370	1,995,474
Wood .....	98,050	27,929	118,571	171,703	111,169	282,872
Furniture and fixtures .....	113,140	14,000	126,440	117,821	2,500	120,321
Paper and allied industries .....	6,545,370	699,169	8,612,166	9,099,560	3,642,510	9,244,966
Primary metals .....	7,053,761	147,287	7,159,081	10,434,484	395,684	10,663,180
Metal fabricating .....	2,361,759	32,602	2,362,759	4,160,003	305,022	4,293,136
Machinery .....	5,309,036	93,529	5,396,840	6,982,317	192,070	7,170,344
Transportation equipment .....	17,366,655	121,825	17,373,480	31,132,110	74,304	31,202,042
Electrical products .....	28,179,519	156,432	28,199,659	33,288,516	344,163	33,435,679
Non-metallic mineral products .....	1,488,330	12,682	1,499,012	1,852,082	51,932	1,861,243
Petroleum and coal products .....	5,529,202	1,180,650	5,592,852	7,583,468	82,604	7,633,266
Chemical and chemical products .....	19,573,959	718,576	20,292,535	24,449,969	589,768	25,021,027
Other manufacturing <sup>4</sup> .....	3,863,690	54,722	3,872,522	7,625,466	31,730	7,657,196
Transportation, storage, communication and other utilities	3,185,165	37,055	3,222,220	4,029,545	117,218	4,146,763
Other non-manufacturing <sup>5</sup> .....	2,990,862	283,175	3,225,987	4,635,726	67,116	4,670,542
<b>Totals</b> .....	<b>113,982,961</b>	<b>4,293,238</b>	<b>113,883,888</b>	<b>160,170,853</b>	<b>8,025,486</b>	<b>163,447,640</b>

<sup>1</sup> These are revised figures. Differences between these expenditures and those published previously are due to a greater response rate, a larger number of firms included in the survey and the companies' own re-examination of their 1961 expenditures.

<sup>2</sup> These figures are not revised since any differences with those published before are believed to be minor.

<sup>3</sup> To avoid double-counting, certain payments, which are extra-mural for one respondent and intra-mural for another, have been subtracted from the sum of all Canadian intra- and extra-mural expenditures. Thus "net industrial R & D expenditures" are not necessarily equal to the sum of the intra- and extra-mural expenditures.

<sup>4</sup> Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.

<sup>5</sup> Includes the construction industry, scientific and engineering services, and trade associations.

TABLE 2. Intra-mural R & D Expenditures, by Industry, 1959-64

Industry	1959	1960 <sup>1</sup>	1961 <sup>2</sup>	1962 <sup>2</sup>	1963	1964 <sup>1</sup>
	dollars					
Mines, quarries and oil wells .....	4,907,029	5,168,654	4,820,816	5,305,551	6,560,188	6,640,782
Manufacturing:						
Food and beverages .....	1,793,626	1,971,900	2,591,489	2,499,484	4,299,244	5,019,982
Rubber .....	1,219,165	1,199,140	1,425,008	1,576,587	1,873,549	1,890,000
Textile .....	1,395,769	1,462,940	1,487,152	1,562,364	1,875,104	1,984,415
Wood .....	102,081	109,096	98,050	148,136	171,703	204,700
Furniture and fixtures .....	27,500	33,156	113,140	123,952	117,821	105,500
Paper and allied industries .....	6,571,953	6,822,565	6,545,370	7,201,684	9,099,560	10,228,722
Primary metals .....	6,626,528	7,557,460	7,053,761	8,217,319	10,434,484	11,111,600
Metal fabricating .....	1,724,907	1,810,620	2,361,759	3,093,503	4,160,003	3,004,136
Machinery .....	3,121,907	3,089,325	5,309,036	5,836,531	6,982,317	6,881,366
Transportation equipment .....	25,570,722	8,072,106	17,366,655	18,291,984	31,132,110	48,159,000
Electrical products .....	15,903,065	17,551,660	28,179,519	28,435,263	33,288,516	37,241,774
Non-metallic mineral products .....	1,353,830	1,444,771	1,488,330	1,502,480	1,852,082	1,907,074
Petroleum and coal products .....	3,761,700	4,224,000	5,529,202	6,450,932	7,583,466	8,875,000
Chemical and chemical products .....	14,133,296	12,818,696	19,573,959	21,321,895	24,449,969	22,620,425
Other manufacturing <sup>3</sup> .....	3,004,378	2,617,766	3,863,690	6,018,869	7,625,466	9,021,108
Transportation, storage, communication and other utilities	2,779,440	3,126,460	3,185,165	3,642,448	4,029,545	9,338,000
Other non-manufacturing <sup>4</sup> .....	2,593,485	2,600,840	2,990,862	3,279,228	4,635,726	5,781,930
<b>Totals</b> .....	<b>96,590,381</b>	<b>81,681,155</b>	<b>113,982,961</b>	<b>124,508,210</b>	<b>160,170,853</b>	<b>190,015,514</b>

<sup>1</sup> Estimates for the years 1960 and 1964 are based on the companies' intentions for these years.

<sup>2</sup> Revised.

<sup>3</sup> Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.

<sup>4</sup> Includes the construction industry, scientific and engineering services, and trade associations.

TABLE 3. Canadian Sources of Funds for Intra-mural R & D, by Industry, 1963

Industry	Reporting company	Parent, affiliated and subsidiary companies	Canadian Federal Government funds received through			Contract work for other companies	Others <sup>1</sup>	Total
			R & D prime contracts	F. & D portion of procurement contracts	Grants in aid of research			
dollars								
Mines, quarries and oil wells .....	6,011,055	4,923	45,600	—	79,300	87,822	54,229	6,282,929
Manufacturing:								
Food and beverages .....	3,973,514	50,846	—	—	173,684	400	100,800	4,299,244
Rubber .....	1,507,637	—	—	—	18,000	—	—	1,525,637
Textile .....	1,858,104	—	—	—	17,000	—	—	1,875,104
Wood .....	113,043	—	—	—	—	—	58,660	171,703
Furniture and fixtures .....	117,821	—	—	—	—	—	—	117,821
Paper and allied industries .....	7,142,082	—	—	—	70,237	140,200	1,578,200	8,930,719
Primary metals .....	10,336,987	25,300	—	—	1,438	7,894	32,662	10,404,281
Metal fabricating .....	3,213,447	3,500	854,929	26,127	48,000	—	14,000	4,160,003
Machinery .....	6,016,826	7,000	258,236	—	1,797	—	—	6,283,859
Transportation equipment .....	15,826,953	—	11,046,668	1,489,000	1,226,023	500	—	29,589,144
Electrical products .....	23,057,649	165,445	7,273,670	1,389,505	694,859	113,797	—	32,694,925
Non-metallic mineral products .....	799,450	—	25,400	—	72,763	—	—	897,613
Petroleum and coal products .....	7,407,713	—	—	—	42,121	133,632	—	7,583,466
Chemical and chemical products .....	21,931,396	156,154	392,597	—	346,352	—	—	22,826,499
Other manufacturing <sup>2</sup> .....	4,634,575	—	2,028,914	135,024	151,262	17,000	—	6,966,775
Transportation, storage, communication and other utilities .....	4,004,545	—	25,000	—	—	—	—	4,029,545
Other non-manufacturing <sup>3</sup> .....	359,482	2,229,010	114,276	—	151,654	1,173,662	73,383	4,101,467
<b>Totals .....</b>	<b>118,312,279</b>	<b>2,642,178</b>	<b>22,065,290</b>	<b>3,039,656</b>	<b>3,094,490</b>	<b>1,674,907</b>	<b>1,911,934</b>	<b>152,740,734</b>
Per cent distribution to total .....	77.5	1.7	14.4	2.0	2.0	1.1	1.3	100.0

<sup>1</sup> Consists largely of other firms and organizations within the same industry which make payments to the reporting company for R & D (e.g. membership fees paid research institute for that industry).

<sup>2</sup> Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.

<sup>3</sup> Includes the construction industry, scientific and engineering services, and trade associations.

TABLE 4. Foreign Sources of Funds for Intra-mural R & D, by Industry, 1963

Industry	Reporting company	Parent, affiliated and subsidiary companies	Contract work for other companies	Others <sup>1</sup>	Total
dollars					
Mines, quarries and oil wells .....	—	22,659	130,600	124,000	277,259
Manufacturing:					
Food and beverages .....	—	—	—	—	—
Rubber .....	—	347,912	—	—	347,912
Textiles .....	—	—	—	—	—
Wood .....	—	—	—	—	—
Furniture and fixtures .....	—	—	—	—	—
Paper and allied industries .....	—	134,841	34,000	—	168,841
Primary metals .....	—	6,883	23,320	—	30,203
Metal fabricating .....	—	—	—	—	—
Machinery .....	26,727	671,731	—	—	698,458
Transportation equipment .....	—	203,032	6,934	1,333,000	1,542,966
Electrical products .....	—	212,891	106,700	274,000	593,591
Non-metallic mineral products .....	—	954,469	—	—	954,469
Petroleum and coal products .....	—	—	—	—	—
Chemical and chemical products .....	—	1,623,470	—	—	1,623,470
Other manufacturing <sup>2</sup> .....	—	42,000	616,691	—	658,691
Transportation, storage, communication and other utilities .....	—	—	—	—	—
Other non-manufacturing <sup>3</sup> .....	1,000	234,914	187,736	110,609	534,259
<b>Totals .....</b>	<b>27,727</b>	<b>4,454,802</b>	<b>1,105,981</b>	<b>1,841,609</b>	<b>7,430,119</b>
Per cent distribution to total .....	0.4	59.9	14.9	24.8	100.0

<sup>1</sup> Includes payments from foreign governments.

<sup>2</sup> Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.

<sup>3</sup> Includes the construction industry, scientific and engineering services, and trade associations.

TABLE 5. Canadian Extra-mural Payments, by Industry and Recipient of Payment, 1963

Industry	Parent, affiliated and subsidiary companies	Commercial laboratories and consultants	Other companies	Educational institutions as R & D contracts	Research institutes as R & D contracts	Governments	Individuals or educational institutions for research scholarships	Industrial or trade co-operative research associations	Foundations, educational and research institutions <sup>1</sup>	Other	Total
dollars											
Mines, quarries and oil wells .....	394,871	168,354	31,500	142,460	314,214	113,624	48,250	31,286	152,021	35,693	1,432,273
Manufacturing:											
Food and beverages .....	88,095	50,695	—	6,900	12,603	2,400	20,800	135,307	106,753	—	423,553
Rubber .....	—	400	—	—	—	—	—	800	300	—	1,500
Textile .....	82,773	3,315	17,589	—	143	—	—	—	56,550	—	160,370
Wood .....	—	3,700	16,707	25,000	5,354	—	—	60,393	—	15	111,169
Furniture and fixtures .....	—	—	—	—	—	—	—	—	—	2,500	2,500
Paper and allied industries .....	1,464,947	60,019	18,431	800	136,946	34,220	750	1,816,761	87,398	22,238	3,642,510
Primary metals .....	66,529	30,262	135,702	47,500	21,940	24,589	10,500	1,377	57,267	18	395,684
Metal fabricating .....	210,353	18,073	30,784	20,290	1,752	750	—	8,740	11,880	2,400	305,022
Machinery .....	—	39,000	38,362	2,906	65,187	—	2,250	100	44,265	—	192,070
Transportation equipment .....	1,500	29,961	12,692	—	1,500	10,885	1,625	—	16,141	—	74,304
Electrical products .....	52,500	63,925	173,218	6,750	—	—	20,700	500	13,070	13,500	344,163
Non-metallic mineral products .....	21,587	24,274	1,375	—	2,691	—	462	1,493	50	—	51,932
Petroleum and coal products .....	—	32,804	—	—	—	—	49,300	—	500	—	82,604
Chemical and chemical products .....	21,253	37,558	166	57,027	9,120	—	167,965	5,894	209,479	81,306	589,768
Other manufacturing <sup>2</sup> .....	—	25,387	—	—	200	933	4,000	60	1,150	—	31,730
Transportation, storage, communication and other utilities .....	—	11,000	—	7,500	12,750	7,500	2,500	10,580	46,750	18,638	117,218
Other non-manufacturing <sup>3</sup> .....	—	35,816	12,000	3,300	6,000	—	—	—	—	10,000	67,116
<b>Totals .....</b>	<b>2,404,408</b>	<b>634,543</b>	<b>488,526</b>	<b>320,433</b>	<b>590,400</b>	<b>194,901</b>	<b>329,102</b>	<b>2,073,291</b>	<b>803,574</b>	<b>186,308</b>	<b>8,025,486</b>
Per cent distribution to total .....	30.0	7.9	6.1	4.0	7.4	2.4	4.1	25.8	10.0	2.3	100.0

<sup>1</sup> For general scientific research.

<sup>2</sup> Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.

<sup>3</sup> Includes the construction industry, scientific and engineering services, and trade associations.

TABLE 6. Foreign Extra-mural Payments, by Industry and Recipient of Payment, 1963

Industry	Parent, affiliated and subsidiary companies	Commercial laboratories and consultants	Other companies	Educational institutions as R & D contracts	Research institutes as R & D contracts	Governments	Individuals or educational institutions for R & D scholarships	Industrial or trade co-operative research associations	Foundations, educational and research institutions <sup>1</sup>	Other	Total
dollars											
Mines, quarries and oil wells .....	856,237	83,353	301	2,980	32,500	—	1,609	233,035	—	10,000	1,220,015
Manufacturing:											
Food and beverages .....	593,641	9,217	—	—	—	—	—	21,305	751	—	624,914
Rubber .....	3,741,188	3,500	—	—	—	—	—	7,250	5,500	—	3,757,438
Textile .....	22,871	3,675	—	—	—	—	—	9,466	—	—	36,012
Wood .....	—	—	—	—	—	—	—	1,598	—	20	1,618
Furniture and fixtures .....	91,000	—	—	—	—	—	—	—	—	—	91,000
Paper and allied industries .....	408,974	5,460	11,300	—	4,865	—	—	3,100	5,200	1,700	440,599
Primary metals .....	5,589,362	147,122	4,361	—	59,000	32,865	57,000	3,589	2,700	3,505	5,899,504
Metal fabricating .....	126,061	19,800	38,500	—	—	—	—	350	2,100	—	186,811
Machinery .....	2,432,471	20,000	37,854	1,188	—	—	—	120	—	—	2,491,633
Transportation equipment .....	2,442,880	—	5,699,000	—	—	—	—	—	—	—	8,141,880
Electrical products .....	1,070,919	16,000	41,050	—	—	—	—	229	—	—	1,128,198
Non-metallic mineral products .....	401,960	128	39,271	—	1,459	—	—	96,431	9,228	114,256	662,733
Petroleum and coal products .....	4,718,924	1,500	—	—	—	—	11,600	—	750	—	4,732,774
Chemical and chemical products .....	4,064,913	41,711	—	—	8,000	—	—	28,303	11,082	—	4,154,009
Other manufacturing <sup>2</sup> .....	1,638,857	12,460	—	—	—	—	—	—	—	—	1,651,317
Transportation, storage, communication and other utilities .....	—	—	2,500,000	—	—	—	—	4,750	540	—	2,505,290
Other non-manufacturing <sup>3</sup> .....	47,704	10,550	15,505	—	—	—	1,500	—	—	—	75,259
<b>Totals .....</b>	<b>28,247,962</b>	<b>374,476</b>	<b>8,387,142</b>	<b>4,168</b>	<b>105,824</b>	<b>32,865</b>	<b>71,709</b>	<b>409,526</b>	<b>37,851</b>	<b>129,481</b>	<b>37,801,004</b>
Per cent distribution to total .....	74.7	1.0	22.2	—	0.3	0.1	0.2	1.1	0.1	0.3	100.0

<sup>1</sup> For general scientific research.

<sup>2</sup> Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.

<sup>3</sup> Includes the construction industry, scientific and engineering services, and trade associations.

**TABLE 7. Payments Made and Received by the Reporting Company for Patents, Licences and Technical "Know-how" Embodying the Results of Research, by Industry, 1963<sup>1</sup>**

Industry	Payments made		Payments received from	
	Inside Canada	Outside Canada	Inside Canada	Outside Canada
	dollars			
Mines, quarries and oil wells .....	74,600	192,806	210,868	159,505
Manufacturing:				
Food and beverages .....	4,739	7,819	-	-
Rubber .....	6,027	1,427,929	-	-
Textile .....	184,242	314,603	2,290	-
Wood .....	-	810	1,500	-
Furniture and fixtures .....	-	2,000	-	-
Paper and allied industries .....	9,447	206,149	13,865	107,800
Primary metals .....	20,506	494,655	18,000	179,300
Metal fabricating .....	38,184	1,634,505	-	30,100
Machinery .....	174,664	783,996	186,814	130,418
Transportation equipment .....	582,669	3,217,848	-	1,219
Electrical products .....	177,731	4,749,559	39,204	41,028
Non-metallic mineral products .....	566	221,189	23,015	21,483
Petroleum and coal products .....	200	1,097,290	-	-
Chemical and chemical products .....	87,056	4,293,640	73,092	309,557
Other manufacturing <sup>2</sup> .....	345,573	290,632	16,656	1,357,217
Transportation, storage, communication and other utilities .....	-	2,200,000	651,994	-
Other non-manufacturing <sup>3</sup> .....	645	-	57,602	-
<b>Totals .....</b>	<b>1,706,849</b>	<b>21,135,430</b>	<b>1,294,900</b>	<b>2,337,627</b>

<sup>1</sup> This table does not represent the Canadian technological balance of payments. Many companies may not perform research and development themselves because they rely entirely on the purchase of patents and licences. Such companies are not covered in a survey of research and development expenditures.  
<sup>2</sup> Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.  
<sup>3</sup> Includes the construction industry, scientific and engineering services, and trade associations.

**TABLE 8. Intra-mural R & D Expenditures, by Industry and Field of Research,<sup>1</sup> 1963**

Industry	Engineering							
	Aeronautical	Chemical	Civil	Electrical	Electronic	Mechanical	Mining	Other
	dollars							
Mines, quarries and oil wells .....	-	911,451	11,960	1,840	-	198,250	709,848	750,514
Manufacturing:								
Food and beverages .....	-	587,103	21,562	21,562	-	219,019	-	56,002
Rubber .....	-	450,970	-	-	-	140,577	-	-
Textile .....	1,499	530,614	-	-	-	106,802	28,478	805,314
Wood .....	-	11,803	67,623	11,802	8,799	2,400	2,933	32,101
Furniture and fixtures .....	-	-	4,274	-	-	59,124	-	52,973
Paper and allied industries .....	-	2,599,358	20,892	31,767	321,111	877,785	-	279,916
Primary metals .....	4,333	448,115	20,900	152,991	156,721	254,478	99,696	2,500
Metal fabricating .....	-	159,167	153,814	522,068	252,736	1,681,062	-	34,858
Machinery .....	-	7,069	155,036	232,609	195,529	6,033,330	64,396	58,750
Transportation equipment .....	25,883,889	32,144	-	112,769	21,947	4,434,708	-	626,500
Electrical products .....	31,269	766,698	-	6,341,381	19,046,413	3,834,768	1,500	48,953
Non-metallic mineral products .....	9,834	225,096	98,238	6,250	94,090	125,973	-	740,170
Petroleum and coal products .....	-	766,276	-	58,258	-	291,292	1,281,685	233,619
Chemical and chemical products .....	314,330	5,082,385	-	206,505	199,650	1,928,942	51,030	119,454
Other manufacturing <sup>2</sup> .....	738,816	198,032	-	787,702	1,235,241	1,982,840	-	315,699
Transportation, storage, communication and other utilities .....	2,644	489,550	221,517	1,642,308	662,624	543,460	-	25,000
Other non-manufacturing <sup>3</sup> .....	69,000	1,834,485	42,978	156,015	54,200	1,269,602	31,001	639,982
<b>Totals .....</b>	<b>27,055,614</b>	<b>15,060,316</b>	<b>818,794</b>	<b>10,287,827</b>	<b>22,249,061</b>	<b>23,984,412</b>	<b>2,270,569</b>	<b>4,822,307</b>
<i>Per cent distribution to total .....</i> %	<i>17.0</i>	<i>9.4</i>	<i>0.5</i>	<i>6.4</i>	<i>13.9</i>	<i>15.0</i>	<i>1.4</i>	<i>3.0</i>

See footnotes at end of table.



TABLE 8. Intra-mural R & D Expenditures, by Industry and Field of Research,<sup>1</sup> 1963 - Concluded

Industry	Chemistry	Geology, geophysics and other earth sciences	Metallurgy	Physics	Agricultural sciences	Forestry					
							dollars				
Mines, quarries and oil wells .....	290,476	411,538	2,946,960	273,561	53,790	-					
Manufacturing:											
Food and beverages .....	1,470,893	-	8,825	-	623,970	-					
Rubber .....	1,074,328	-	-	-	-	-					
Textile .....	313,827	-	-	42,154	-	-					
Wood .....	-	-	-	-	-	24,242					
Furniture and fixtures .....	-	-	1,450	-	-	-					
Paper and allied industries .....	3,438,834	-	23,030	639,982	6,963	571,625					
Primary metal .....	6,334	148,050	9,106,754	28,610	-	-					
Metal fabricating .....	-	-	549,595	90,038	91,419	-					
Machinery .....	-	-	119,974	-	7,571	108,053					
Transportation equipment .....	-	-	-	4,800	15,032	-					
Electrical products .....	728,546	1,500	224,139	2,254,603	-	-					
Non-metallic mineral products .....	222,488	30,037	46,420	233,985	-	-					
Petroleum and coal products .....	3,320,163	1,515,657	-	58,258	58,258	-					
Chemical and chemical products .....	11,789,466	-	317,189	574,205	123,189	-					
Other manufacturing <sup>2</sup> .....	611,560	40,425	127,774	825,117	62,737	-					
Transportation, storage, communication and other utilities	-	68,800	337,920	35,722	-	-					
Other non-manufacturing <sup>3</sup> .....	82,240	-	413,033	17,823	1,250	1,167					
<b>Totals .....</b>	<b>23,349,155</b>	<b>2,216,007</b>	<b>14,223,063</b>	<b>5,251,132</b>	<b>1,044,179</b>	<b>705,087</b>					
<i>Per cent distribution to total .....</i>	<i>14.6</i>	<i>1.4</i>	<i>8.9</i>	<i>3.3</i>	<i>0.7</i>	<i>0.4</i>					
							Biological sciences	Medicine	Pharmacy	Other	Total
							dollars				
Mines, quarries and oil wells .....	-	-	-	-	-	6,560,188					
Manufacturing:											
Food and beverages .....	898,796	-	-	-	411,512	4,299,244					
Rubber .....	-	-	-	-	35,400	1,873,549					
Textile .....	31,300	-	-	-	15,116	1,875,104					
Wood .....	-	-	-	-	10,000	171,703					
Furniture and fixtures .....	-	-	-	-	-	117,821					
Paper and allied industries .....	-	-	-	-	288,295	9,099,560					
Primary metal .....	-	-	-	-	5,000	10,434,484					
Metal fabricating .....	-	-	-	-	625,246	4,160,003					
Machinery .....	-	-	-	-	-	6,982,317					
Transportation equipment .....	-	-	-	-	321	31,132,110					
Electrical products .....	-	8,746	-	-	-	33,288,516					
Non-metallic mineral products .....	-	-	-	-	19,501	1,852,082					
Petroleum and coal products .....	-	-	-	-	-	7,583,466					
Chemical and chemical products .....	273,617	1,962,782	381,598	1,125,627	24,449,969						
Other manufacturing <sup>2</sup> .....	-	-	9,849	689,674	7,625,466						
Transportation, storage, communication and other utilities	-	-	-	-	-	4,029,545					
Other non-manufacturing <sup>3</sup> .....	1,250	13,250	1,250	5,200	4,635,726						
<b>Totals .....</b>	<b>1,204,963</b>	<b>1,984,778</b>	<b>392,697</b>	<b>3,230,892</b>	<b>160,170,853</b>						
<i>Per cent distribution to total .....</i>	<i>0.8</i>	<i>1.2</i>	<i>0.2</i>	<i>2.0</i>	<i>100.0</i>						

<sup>1</sup> Branches of engineering or scientific disciplines. Because of the nature of the product, a company in one industry may be engaged in P & D in more than one field of research. Even more commonly, one industry is involved in several such fields.  
<sup>2</sup> Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.  
<sup>3</sup> Includes the construction industry, scientific and engineering services, and trade associations.

TABLE 9. Intra-mural R & D Expenditures, by Industry and Product Group,<sup>1</sup> 1963.

Industry	Food and beverages			Tobacco products	Rubber products	Textiles	
	Foods for human consumption	Animal feeds	Beverages			Synthetic textiles	Other textiles
	dollars						
Mines, quarries and oil wells .....	22,500	22,500	-	-	-	-	-
Manufacturing:							
Food and beverages .....	2,351,343	471,603	1,078,611	-	-	-	-
Rubber .....	-	-	-	-	380,122	-	23,600
Textile .....	-	-	-	-	-	535,626	958,575
Wood .....	-	-	-	-	-	-	-
Furniture and fixtures .....	-	-	-	-	-	-	-
Paper and allied industries .....	-	-	-	-	26,200	67,768	-
Primary metals .....	-	-	-	-	-	-	-
Metal fabricating .....	-	-	-	-	-	-	-
Machinery .....	45,464	-	5,400	371	31,444	1,113	15,000
Transportation equipment .....	-	-	321	-	5,427	-	-
Electrical products .....	-	-	-	-	-	-	-
Non-metallic mineral products .....	-	-	-	-	5,980	-	103,838
Petroleum and coal products .....	-	-	-	-	-	-	-
Chemical and chemical products .....	598,838	17,167	3,479	-	2,360,513	2,787,424	45,338
Other manufacturing <sup>2</sup> .....	-	-	-	808,383	3,283	1,550	22,096
Transportation, storage, communication and other utilities .....	-	-	-	-	-	-	-
Other non-manufacturing <sup>3</sup> .....	18,750	-	-	-	-	1,155,254	35,016
<b>Totals .....</b>	<b>3,036,895</b>	<b>511,270</b>	<b>1,087,811</b>	<b>808,754</b>	<b>2,612,969</b>	<b>4,548,735</b>	<b>1,203,463</b>
<i>Per cent distribution to total</i> .....	<i>1.9</i>	<i>0.3</i>	<i>0.7</i>	<i>0.5</i>	<i>1.8</i>	<i>2.8</i>	<i>0.8</i>
	Paper products		Other wood products	Mining	Smelting and refining	Rolling, casting and extruding	
	Newsprint	Other paper products					
	dollars						
Mines, quarries and oil wells .....	-	-	-	1,224,402	2,115,189	891,384	
Manufacturing:							
Food and beverages .....	-	1,385	-	-	-	-	
Rubber .....	-	26,700	47,200	23,600	-	-	
Textile .....	-	-	-	-	-	-	
Wood .....	-	-	171,203	-	-	-	
Furniture and fixtures .....	-	-	4,000	-	-	-	
Paper and allied industries .....	1,781,072	4,587,203	844,541	115,150	-	-	
Primary metals .....	420	210	210	62,417	8,001,820	1,174,268	
Metal fabricating .....	8,260	113,123	-	-	-	245,505	
Machinery .....	213,363	169,714	210,218	228,598	-	34,259	
Transportation equipment .....	7,821	-	-	568	568	19,948	
Electrical products .....	-	-	-	-	-	-	
Non-metallic mineral products .....	-	28,944	-	-	-	-	
Petroleum and coal products .....	-	-	-	582,584	-	-	
Chemical and chemical products .....	2,189	7,556	66,795	89,671	237,200	24,909	
Other manufacturing <sup>2</sup> .....	-	22,600	-	-	-	-	
Transportation, storage, communication and other utilities .....	-	-	-	-	-	-	
Other non-manufacturing <sup>3</sup> .....	269,120	243,290	124,760	166,375	135,889	25,157	
<b>Totals .....</b>	<b>2,309,245</b>	<b>5,200,725</b>	<b>1,468,927</b>	<b>2,493,365</b>	<b>10,490,666</b>	<b>2,415,863</b>	
<i>Per cent distribution to total</i> .....	<i>1.4</i>	<i>3.2</i>	<i>0.9</i>	<i>1.6</i>	<i>6.5</i>	<i>1.5</i>	

See footnotes at end of table.



TABLE 9. Intra-mural R & D Expenditures, by Industry and Product Group<sup>1</sup>, 1963 - Concluded

Industry	Chemical and chemical products					Scientific and professional equipment	Other	Total
	Drugs and medicines	Industrial chemicals	Mixed fertilizers	Plastics and synthetic resins	Other chemicals or chemical products			
	dollars							
Mines, quarries and oil wells .....	—	124,389	645,480	—	—	229,000	65,016	6,560,188
Manufacturing:								
Food and beverages .....	245,764	80,669	—	—	—	63,324	—	4,299,244
Rubber .....	11,800	507,400	—	142,845	69,582	—	313,200	1,873,549
Textile .....	31,300	—	—	129,036	17,117	—	203,450	1,875,104
Wood .....	—	—	—	—	—	—	500	171,703
Furniture and fixtures .....	—	—	—	—	—	—	61,774	117,821
Paper and allied industries .....	—	503,650	—	798,377	108,000	23,030	2,754	9,099,560
Primary metals .....	—	168	—	—	—	13,346	658,193	10,434,484
Metal fabricating .....	—	—	—	19,255	3,745	—	951,389	4,160,003
Machinery .....	1,377	927	—	—	821	1,820	27,061	6,982,317
Transportation equipment .....	—	11,909	—	549	—	80,743	2,826,910	31,132,110
Electrical products .....	—	—	—	139,448	7,350	718,446	496,314	33,288,516
Non-metallic mineral products .....	—	18,747	—	—	—	—	96,181	1,852,082
Petroleum and coal products .....	—	—	—	15,400	—	116,517	2,679,887	7,583,466
Chemical and chemical products .....	3,815,467	3,892,123	61,030	3,309,407	2,138,666	38,115	2,218,191	24,449,969
Other manufacturing <sup>2</sup> .....	9,849	1,600	—	54,411	9,800	2,763,440	1,114,498	7,625,466
Transportation, storage, communication and other utilities .....	—	5,288	—	3,305	—	—	2,625,239	4,029,545
Other non-manufacturing <sup>3</sup> .....	33,166	14,900	—	56,449	73,016	64,356	712,331	4,635,726
<b>Totals .....</b>	<b>4,148,723</b>	<b>5,161,770</b>	<b>706,510</b>	<b>4,668,482</b>	<b>2,428,097</b>	<b>4,092,137</b>	<b>15,052,888</b>	<b>160,170,853</b>
<i>Per cent distribution to total .....</i> %	2.6	3.2	0.4	2.9	1.5	2.6	9.4	100.0

<sup>1</sup> This table is meant to indicate the extent to which the results of R & D performed within one industry can be utilized in the manufacture of products of other industries. It should be noted that in many cases the activities of a firm cover several industries, although the firm, for survey purposes, can be classified under only one industry.

<sup>2</sup> Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.

<sup>3</sup> Includes the construction industry, scientific and engineering services, and trade associations.

TABLE 10. Intra-mural R & D Expenditures, by Industry and Area of Research, 1963

Industry	Nuclear energy	Space travel and communications	Defence	All other	Total
	dollars				
Mines, quarries and oil wells .....	287,113	—	184,717	6,088,358	6,560,188
Manufacturing:					
Food and beverages .....	—	—	8,415	4,290,829	4,299,244
Rubber .....	—	—	38,500	1,835,049	1,873,549
Textile .....	525	—	29,377	1,845,202	1,875,104
Wood .....	—	—	—	171,703	171,703
Furniture and fixtures .....	—	—	—	117,821	117,821
Paper and allied industries .....	—	—	23,030	9,076,530	9,099,560
Primary metals .....	29,030	—	6,499	10,398,955	10,434,484
Metal fabricating .....	15,200	—	790,086	3,354,717	4,160,003
Machinery .....	—	—	220,568	6,761,749	6,982,317
Transportation equipment .....	19,569	8,621,671	11,686,293	10,804,577	31,132,110
Electrical products .....	3,085,064	742,399	10,084,763	19,376,290	33,288,516
Non-metallic mineral products .....	64,988	9,284	25,975	1,751,835	1,852,082
Petroleum and coal products .....	—	—	—	7,583,466	7,583,466
Chemical and chemical products .....	91,574	394,360	174,201	23,789,834	24,449,969
Other manufacturing <sup>1</sup> .....	861,774	1,012,450	2,505,304	3,245,938	7,625,466
Transportation, storage, communication and other utilities .....	—	120,000	60,000	3,849,545	4,029,545
Other non-manufacturing <sup>2</sup> .....	788,136	—	455,857	3,391,733	4,635,726
<b>Totals .....</b>	<b>3,242,973</b>	<b>10,900,164</b>	<b>26,293,585</b>	<b>117,734,131</b>	<b>160,170,853</b>
<i>Per cent distribution to total .....</i> %	3.3	6.8	16.4	73.5	100.0

<sup>1</sup> Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.

<sup>2</sup> Includes the construction industry, scientific and engineering services, and trade associations.

TABLE 11. Intra-mural R & D Expenditures, by Industry and Type of Research-development, 1963

Industry	Basic research	Applied research	Development	Total
Mines, quarries and oil wells .....	161,921	2,295,811	4,102,456	6,560,188
Manufacturing:				
Food and beverages .....	373,718	1,180,539	2,744,987	4,299,244
Rubber .....	462,837	464,439	946,273	1,873,549
Textile .....	69,942	284,121	1,521,041	1,875,104
Wood .....	2,877	88,646	80,180	171,703
Furniture and fixtures .....	—	2,580	115,241	117,821
Paper and allied industries .....	1,524,363	3,467,654	4,107,543	9,099,560
Primary metals .....	847,949	1,935,939	7,650,596	10,434,484
Metal fabricating .....	145,267	639,963	3,374,773	4,160,003
Machinery .....	20,620	710,028	6,251,669	6,982,317
Transportation equipment .....	206,466	4,176,001	26,749,643	31,132,110
Electrical products .....	1,192,318	4,073,567	28,022,631	33,288,516
Non-metallic mineral products .....	108,533	1,118,527	825,022	1,852,082
Petroleum and coal products .....	645,829	4,241,914	2,695,723	7,583,466
Chemical and chemical products .....	1,564,808	6,841,334	16,043,827	24,449,969
Other manufacturing <sup>1</sup> .....	595,819	1,583,424	5,446,223	7,625,466
Transportation, storage, communication and other utilities .....	101,010	1,544,618	2,383,917	4,029,545
Other non-manufacturing <sup>2</sup> .....	529,546	1,977,666	2,128,514	4,635,726
<b>Totals</b> .....	<b>8,553,823</b>	<b>36,626,771</b>	<b>114,990,259</b>	<b>160,170,833</b>
<i>Per cent distribution to total</i> .....	5.3	22.9	71.8	100.0

<sup>1</sup> Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.  
<sup>2</sup> Includes the construction industry, scientific and engineering services, and trade associations.

TABLE 12. Capital Expenditures on New or Extended Facilities for Use in R & D Activities, 1961-64

Industry	Land and Buildings			
	1961	1962	1963	1964 <sup>1</sup>
	dollars			
Mines, quarries and oil wells .....	28,117	264,220	880,981	434,600
Manufacturing:				
Food and beverages .....	223,587	410,860	250,687	613,000
Rubber .....	—	—	217,884	100,000
Textile .....	—	—	—	27,635
Wood .....	53,081	36,242	605	—
Furniture and fixtures .....	—	—	—	—
Paper and allied industries .....	31,364	843,490	2,232,768	433,450
Primary metals .....	366,690	559,226	1,140,404	662,000
Metal fabricating .....	139,800	73,904	101,787	133,000
Machinery .....	—	93,634	121,636	173,600
Transportation equipment .....	—	20,891	21,000	16,500
Electrical products .....	999,387	173,376	910,554	3,028,732
Non-metallic mineral products .....	15,622	29,870	49,100	—
Petroleum and coal products .....	250,000	263,000	2,112,311	504,000
Chemical and chemical products .....	2,347,274	1,093,724	2,194,389	2,494,870
Other manufacturing <sup>2</sup> .....	68,587	50,002	5,190	699,680
Transportation, storage, communication and other utilities .....	1,818,000	163,900	150,000	958,000
Other non-manufacturing <sup>1</sup> .....	—	7,607	219,780	228,000
<b>Totals</b> .....	<b>6,341,509</b>	<b>4,083,946</b>	<b>10,609,076</b>	<b>10,507,067</b>
Land only .....	(108,837)	(951,934)	(1,349,191)	(50,300)

See footnotes at end of table.

TABLE 12. Capital Expenditures on New or Extended Facilities for Use in R & D Activities, 1961 - 64 - Concluded

Industry	Equipment				Total			
	1961	1962	1963	1964 <sup>1</sup>	1961	1962	1963	1964 <sup>2</sup>
	dollars							
Mines, quarries and oil wells .....	478,050	304,690	908,562	2,371,108	506,167	568,910	1,789,543	2,805,708
Manufacturing:								
Food and beverages .....	179,257	531,780	739,659	786,035	402,844	942,640	990,346	1,399,035
Rubber .....	109,406	88,430	123,000	126,500	109,406	88,430	340,884	226,500
Textile .....	92,164	98,782	120,830	124,600	92,164	98,782	120,830	152,235
Wood .....	13,955	53,681	43,295	5,675	67,036	89,923	43,900	5,675
Furniture and fixtures .....	700	700	1,200	2,500	700	700	1,200	2,500
Paper and allied industries .....	373,147	445,432	1,633,236	1,929,500	404,511	1,288,922	3,866,004	2,362,950
Primary metals .....	1,045,954	430,100	1,058,485	3,416,000	1,412,644	989,326	2,198,889	4,078,000
Metal fabricating .....	57,049	255,205	236,249	170,800	196,849	329,109	338,036	303,800
Machinery .....	181,924	189,140	259,320	365,402	181,924	282,774	380,956	539,002
Transportation equipment .....	19,591	33,013	241,857	314,200	19,591	53,904	262,857	330,700
Electrical products .....	2,752,008	3,451,528	7,261,054	4,892,850	3,751,395	3,624,904	8,171,608	7,921,582
Non-metallic mineral products .....	23,599	38,656	113,308	83,000	39,221	68,526	162,408	83,000
Petroleum and coal products .....	290,069	746,095	1,402,533	2,307,100	540,069	1,009,095	3,514,844	2,811,100
Chemical and chemical products .....	1,329,266	1,651,001	3,879,345	4,112,200	3,676,540	2,744,725	6,073,734	6,607,070
Other manufacturing <sup>3</sup> .....	144,120	124,909	275,713	491,336	212,707	174,911	280,903	1,191,016
Transportation, storage, communication and other utilities .....	47,668	212,555	407,982	237,000	1,865,668	376,455	557,982	1,195,000
Other non-manufacturing <sup>3</sup> .....	21,195	71,616	164,357	367,000	21,195	79,223	384,137	595,000
<b>Totals .....</b>	<b>7,159,122</b>	<b>8,727,313</b>	<b>18,869,985</b>	<b>22,102,806</b>	<b>13,500,631</b>	<b>12,811,259</b>	<b>29,479,061</b>	<b>32,609,873</b>

<sup>1</sup> Estimated.

<sup>2</sup> Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.

<sup>3</sup> Includes the construction industry, scientific and engineering services, and trade associations.

TABLE 13. Personnel Engaged in R & D, by Industry and Class, 1963

Industry	Professional personnel			Total	Supporting personnel			Total
	Level of training				R & D technicians	Skilled craftsmen	Other	
	Bachelor	Master	Doctorate					
	number							
Mines, quarries and oil wells .....	245	42	27	314	242	23	106	371
Manufacturing:								
Food and beverages .....	128	27	44	199	170	19	82	271
Rubber .....	68	6	21	95	77	10	34	121
Textile .....	28	15	2	45	68	12	103	203
Wood .....	15	1	-	16	9	4	3	16
Furniture and fixtures .....	3	-	-	3	9	8	1	18
Paper and allied industries .....	185	44	66	295	300	46	140	486
Primary metals .....	252	45	41	338	377	177	223	777
Metal fabricating .....	131	15	2	148	85	54	63	202
Machinery .....	172	18	6	196	197	274	149	620
Transportation equipment .....	529	55	10	594	574	190	173	937
Electrical products .....	1,196	156	65	1,417	1,040	193	611	1,844
Non-metallic mineral products .....	61	5	4	70	73	11	52	136
Petroleum and coal products .....	95	36	51	182	143	28	41	212
Chemical and chemical products .....	742	123	250	1,115	783	103	339	1,225
Other manufacturing <sup>1</sup> .....	332	41	19	392	228	61	107	416
Transportation, storage, communication and other utilities .....	129	37	17	183	107	19	84	210
Other non-manufacturing <sup>3</sup> .....	115	46	32	193	186	28	85	299
<b>Totals .....</b>	<b>4,426</b>	<b>712</b>	<b>657</b>	<b>5,795</b>	<b>4,688</b>	<b>1,280</b>	<b>2,396</b>	<b>8,364</b>

<sup>1</sup> Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.

<sup>3</sup> Includes the construction industry, scientific and engineering services, and trade associations.

TABLE 14. Professional Personnel Engaged in R & D, by Industry and Field of Training, 1963

Industry	Engineers										Chemists	Food technologists	Geologists and other earth scientists
	Aero-nautical	Chemical	Civil	Electrical	Electronic	Forestry	Mechanical	Mining	Other	Total			
	number												
Mines, quarries and oil wells .....	—	61	6	4	4	—	12	20	18	125	64	—	6
Manufacturing:													
Food and beverages .....	—	28	1	1	—	—	3	—	1	34	74	24	—
Rubber .....	—	2	—	—	—	—	8	—	—	21	53	—	—
Textile .....	—	13	—	—	—	—	3	—	9	25	13	—	—
Wood .....	—	2	2	1	—	5	5	—	1	16	—	—	—
Furniture and fixtures .....	—	—	—	—	—	—	3	—	—	3	—	—	—
Paper and allied industries .....	—	69	2	1	1	18	29	—	3	123	126	—	—
Primary metals .....	—	90	3	16	—	—	49	8	8	174	30	—	3
Metal fabricating .....	—	14	22	24	5	—	41	—	1	107	14	2	—
Machinery .....	2	2	—	11	1	—	149	—	2	167	2	—	—
Transportation equipment .....	119	17	7	55	15	—	286	—	14	513	3	—	—
Electrical products .....	—	26	1	451	414	—	248	4	16	1,160	18	—	—
Non-metallic mineral products .....	—	17	4	3	—	—	6	—	5	35	16	—	4
Petroleum and coal products .....	—	45	2	—	—	—	5	4	3	59	73	—	28
Chemical and chemical products .....	7	264	3	11	4	—	75	1	5	370	514	1	2
Other manufacturing <sup>1</sup> .....	21	9	4	75	65	—	99	1	22	296	23	—	2
Transportation, storage, communication and other utilities .....	1	13	7	101	10	1	16	—	1	150	3	—	4
Other non-manufacturing <sup>2</sup> .....	5	23	8	5	3	1	42	1	9	95	50	8	1
<b>Totals</b> .....	<b>155</b>	<b>706</b>	<b>70</b>	<b>759</b>	<b>522</b>	<b>25</b>	<b>1,079</b>	<b>39</b>	<b>118</b>	<b>3,473</b>	<b>1,076</b>	<b>35</b>	<b>50</b>
<i>Per cent distribution to total</i> .....	<i>2.7</i>	<i>12.2</i>	<i>1.2</i>	<i>13.1</i>	<i>9.0</i>	<i>0.4</i>	<i>18.6</i>	<i>0.7</i>	<i>2.0</i>	<i>59.9</i>	<i>18.6</i>	<i>0.6</i>	<i>0.9</i>
	Mathematicians	Metalurgists	Physicists	Agricultural scientists	Biological scientists	Medical scientists	Pharmacists	Other	Sub-total	R & D administrators	Total		
	number												
Mines, quarries and oil wells .....	4	90	6	2	—	—	—	—	172	17	314		
Manufacturing:													
Food and beverages .....	2	—	1	31	21	—	1	1	155	10	199		
Rubber .....	2	—	2	3	—	—	1	—	61	13	95		
Textile .....	—	—	1	—	—	1	—	—	15	5	45		
Wood .....	—	—	—	—	—	—	—	—	—	—	16		
Furniture and fixtures .....	—	—	—	—	—	—	—	—	—	—	3		
Paper and allied industries .....	3	1	12	1	—	—	—	7	150	22	295		
Primary metals .....	—	92	16	—	—	—	—	9	150	14	338		
Metal fabricating .....	4	6	5	3	—	—	—	1	35	6	148		
Machinery .....	3	4	3	—	—	—	—	—	12	17	196		
Transportation equipment .....	34	19	16	—	—	—	—	1	73	8	594		
Electrical products .....	21	21	88	—	—	—	—	—	148	109	1,417		
Non-metallic mineral products .....	1	1	9	1	—	—	—	—	32	3	70		
Petroleum and coal products .....	—	—	1	1	—	—	—	3	106	17	182		
Chemical and chemical products .....	4	9	22	10	73	18	19	12	682	63	1,115		
Other manufacturing <sup>1</sup> .....	16	5	30	—	—	—	1	1	78	18	392		
Transportation, storage, communication and other utilities .....	1	10	1	—	1	—	—	1	21	12	183		
Other non-manufacturing <sup>2</sup> .....	6	14	7	—	1	1	—	—	88	10	193		
<b>Totals</b> .....	<b>101</b>	<b>272</b>	<b>220</b>	<b>52</b>	<b>96</b>	<b>18</b>	<b>22</b>	<b>36</b>	<b>1,978</b>	<b>344</b>	<b>5,795</b>		
<i>Per cent distribution to total</i> .....	<i>1.7</i>	<i>4.7</i>	<i>3.8</i>	<i>0.9</i>	<i>1.7</i>	<i>0.3</i>	<i>0.4</i>	<i>0.6</i>	<i>34.2</i>	<i>5.9</i>	<i>100.0</i>		

<sup>1</sup> Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.

<sup>2</sup> Includes the construction industry, scientific and engineering services, and trade associations.

**TABLE 15. Professional Personnel Engaged in R & D Activities, by Industry and Type of Research-development, 1963**

Industry	Basic research	Applied research	Development	Total
Mines, quarries and oil wells .....	8	108	198	314
<b>Manufacturing:</b>				
Food and beverages .....	15	54	130	199
Rubber .....	26	22	47	95
Textile .....	—	6	39	45
Wood .....	—	9	7	16
Furniture and fixtures .....	—	—	3	3
Paper and allied industries .....	58	110	127	295
Primary metals .....	27	80	231	338
Metal fabricating .....	10	33	105	148
Machinery .....	1	22	173	196
Transportation equipment .....	8	75	511	594
Electrical products .....	40	209	1,188	1,417
Non-metallic mineral products .....	6	37	27	70
Petroleum and coal products .....	22	78	82	182
Chemical and chemical products .....	75	305	735	1,115
Other manufacturing <sup>1</sup> .....	40	108	244	392
Transportation, storage, communication and other utilities .....	7	73	103	183
Other non-manufacturing <sup>2</sup> .....	37	79	77	193
<b>Totals .....</b>	<b>380</b>	<b>1,408</b>	<b>4,007</b>	<b>5,795</b>
<i>Per cent distribution to total</i> .....	% 6.6	24.3	69.1	100.0

<sup>1</sup> Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.  
<sup>2</sup> Includes the construction industry, scientific and engineering services, and trade associations.

**TABLE 16. Number of Canadian Firms Reporting R & D Expenditures, by Industry, 1963**

Industry	Firms conducting intra-mural R & D <sup>1</sup>	Firms paying for extra-mural R & D only <sup>2</sup>	Total
Mines, quarries and oil wells .....	38	14	52
<b>Manufacturing:</b>			
Food and beverages .....	49	9	58
Rubber .....	8	3	11
Textile .....	17	2	19
Wood .....	9	5	14
Furniture and fixtures .....	6	—	6
Paper and allied industries .....	27	14	41
Primary metals .....	28	7	35
Metal fabricating .....	41	3	44
Machinery .....	62	4	86
Transportation equipment .....	33	5	38
Electrical products .....	88	7	95
Non-metallic mineral products .....	21	8	29
Petroleum and coal products .....	6	4	10
Chemical and chemical products .....	74	12	86
Other manufacturing <sup>3</sup> .....	38	7	45
Transportation, storage, communication and other utilities .....	9	12	21
Other non-manufacturing <sup>4</sup> .....	28	3	31
<b>Totals .....</b>	<b>582</b>	<b>119</b>	<b>701</b>

<sup>1</sup> Such firms may or may not have extra-mural expenditures as well. Permanent R & D units were reported by 406 of these firms (see Table 17).

<sup>2</sup> Includes companies paying for R & D performed both in Canada and abroad.

<sup>3</sup> Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.

<sup>4</sup> Includes the construction industry, scientific and engineering services, and trade associations.



TABLE 17. Year of Establishment of a Permanent Unit<sup>1</sup> for R & D, by Industry

Industry	Number of firms establishing a unit				
	Before 1930	1930-49	1950-59	1960-64	Total
Mines, quarries and oil wells .....	1	5	12	9	27
Manufacturing:					
Food and beverages .....	2	10	8	13	33
Rubber .....	1	2	2	2	7
Textile .....	-	4	5	5	14
Wood .....	-	-	3	3	6
Furniture and fixtures .....	-	-	-	-	-
Paper and allied industries .....	4	8	4	5	21
Primary metals .....	1	7	5	6	19
Metal fabricating .....	2	-	12	13	27
Machinery .....	4	2	15	18	39
Transportation equipment .....	-	4	6	10	20
Electrical products .....	4	15	20	26	65
Non-metallic mineral products .....	1	4	5	4	14
Petroleum and coal products .....	1	1	-	4	6
Chemical and chemical products .....	6	12	17	20	55
Other manufacturing <sup>2</sup> .....	2	3	13	15	33
Transportation, storage, communication and other utilities .....	1	2	1	-	4
Other non-manufacturing <sup>3</sup> .....	1	-	5	10	16
<b>Totals</b> .....	<b>31</b>	<b>79</b>	<b>133</b>	<b>163</b>	<b>406</b>
<i>Per cent distribution to total</i> .....	<i>7.6</i>	<i>19.5</i>	<i>32.8</i>	<i>40.1</i>	<i>100.0</i>

<sup>1</sup> Many firms assign personnel from manufacturing or production divisions to research or development work on a part-time basis. In such cases they would not be considered to have a permanent unit for R & D.

<sup>2</sup> Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.

<sup>3</sup> Includes the construction industry, scientific and engineering services, and trade associations.

TABLE 18. Dollars Spent on Canadian R & D in 1963 per One Hundred Dollars of Sales,<sup>1</sup> by Industry

Industry	Expenditure
	dollars
Electrical products .....	3.18
Chemical and chemical products .....	2.22
Other manufacturing <sup>2</sup> .....	1.68
Rubber .....	1.18
Mines, quarries and oil wells .....	1.11
Machinery .....	1.07
Transportation equipment .....	0.93
<b>Average, all industries</b> .....	<b>0.84</b>
Metal fabricating .....	0.78
Primary metals .....	0.68
Textile .....	0.68
Non-metallic mineral products .....	0.86
Paper and allied industries .....	0.45
Petroleum and coal products .....	0.45
Furniture and fixtures .....	0.44
Food and beverages .....	0.19
Transportation, storage, communication and other utilities .....	0.17
Wood .....	0.16

<sup>1</sup> These are the sales (excluding the sales of goods purchased for re-sale) only of those firms reporting payments for R & D performed in Canada.

<sup>2</sup> Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.

**SECTION III**

**QUESTIONNAIRES**

SCIENTIFIC RESEARCH AND DEVELOPMENT IN CANADIAN INDUSTRY

PRELIMINARY SURVEY

Scientific research and development is investigative work carried out:

- a) to acquire new knowledge,
- b) to devise and develop new products or processes, or
- c) to apply newly acquired knowledge in making improvements to existing products or processes.

Scientific R & D does NOT include:

- a) market research,
- b) operations research (except when the design of mechanical systems is involved),
- c) sales promotion or technical services,
- d) quality control of products,
- e) routine testing of materials, or
- f) prospecting or exploring for minerals and mineral fuels.

- 
1. In 1963, did this company either perform any scientific R & D, or pay for R & D performed by others?      Yes       No
2. Does this company intend to perform or pay for scientific R & D during the next two years?      Yes       No
- 

Please return this letter as soon as possible. An addressed, postage-free envelope is enclosed.

Thank you.

Business Finance Division

DOMINION BUREAU OF STATISTICS  
Business Finance Division  
OTTAWA, ONTARIO

SCIENTIFIC RESEARCH AND DEVELOPMENT IN CANADIAN INDUSTRY  
1963

Please correct any mistake in name or address.

**NOTE.** This survey is taken in conformity with the requirements of the Statistics Act (Chapter 257, Revised Statutes of Canada 1952), Section 15 of the Act states that individual returns are not to be published or divulged to anyone other than personnel of the Bureau of Statistics, and also stipulates that publications must be so arranged that particulars about any individual firm cannot be identified.

**PURPOSE OF THE SURVEY.** This survey is undertaken at the request of the National Research Council of Canada and other interested agencies. Its purpose is to obtain principal statistics which will provide a broad measure of the research and development activities of Canadian industry. Similar inquiries were conducted for the years 1955, 1957, 1959 and 1961. The present survey is particularly important because of the measures to encourage industrial research which the Federal Government has implemented since 1961.

**GENERAL INSTRUCTIONS.**

1. Scientific research and development are defined on page 6.
2. Do NOT include any capital depreciation costs or capital consumption allowances in any answer of this questionnaire.
3. Please answer all questions. Your best estimates are satisfactory when precise figures are not available.
4. Mail one completed copy of this schedule within 6 WEEKS of receipt to:

Business Finance Division  
Dominion Bureau of Statistics  
Ottawa, Ontario

Name and address of person responsible for completing this return.

\_\_\_\_\_  
Name Official Position

\_\_\_\_\_  
Business Address Date 1964

Period covered: from \_\_\_\_\_ to \_\_\_\_\_

1. Total current costs of scientific R & D done within the reporting company in Canada in 1963 ..... \$ \_\_\_\_\_

Current costs include:

- (a) Wages, salaries and related costs, including "fringe benefits", of all research personnel, including scientists and all classes of supporting personnel.
- (b) Materials and supplies used, including the costs of purchasing, receiving, inspection, storage and transportation.
- (c) Literature purchased to provide background information necessary for research operations.
- (d) Overhead, which is an estimated share of the costs of the functions supporting R & D activity.

**NOTE.** Do NOT include payments to other firms or organizations; these are covered in Question 4.

2. Total current costs of scientific R & D done within the reporting company (comparable to Question 1):

(a) in 1961 ..... \$ \_\_\_\_\_

(b) in 1962 ..... \$ \_\_\_\_\_

**NOTE.** If a figure has been entered for 1961, this is the figure reported by your company in the 1961 questionnaire. If no figure has been entered, no return was received from your company in the 1961 survey. In this case, please estimate these costs.

	In Canada	Outside Canada
3. Sources of funds for the R & D described in Question 1:	\$	\$
(a) Reporting company .....		
(b) Parent, affiliated and subsidiary companies .....		
(c) Canadian Federal Government through:		
(1) R & D prime contracts .....		
(2) the R & D portion of procurement contracts .....		
(3) grants in aid of research .....		
(d) Contract work for other companies .....		
(e) Others .....		
.....		
.....		
Totals (the sum of these two totals must equal the amount of Question 1) .....		

NOTE. These are funds such as grants, contractual payments or regular assessments of affiliates which are used to support the R & D programme of the reporting company. Funds received from the sale of information or patents resulting from the research activities of the reporting company are NOT to be included here, but are covered in Question 5(b).

4. Payments made in 1963 by the reporting company for scientific R & D performed by others.

Payments made to:	In Canada	Outside Canada
	\$	\$
(a) Parent, affiliated and subsidiary companies .....		
(b) Commercial laboratories and consultants .....		
(c) Other companies .....		
(d) Educational institutions as R & D contracts .....		
(e) Research institutes as R & D contracts .....		
(f) Governments .....		
(g) Individuals or educational institutions for scientific research scholarships .....		
(h) Industrial or trade cooperative research associations .....		
(i) Research foundations, educational and research institutions for general scientific research .....		
(j) Other .....		
.....		
Totals .....		

NOTE. In 4(h) membership fees to organizations such as the Pulp and Paper Research Institute would be included. Payments made to such an organization for a research contract would, however, be included in 4(e). In 4(i) contributions to research foundations such as the National Heart Foundation, or grants (not scholarships) to universities for scientific research are included.

5. (a) Payments made in 1963 by the reporting company for patents, licences and technical "know-how" embodying the results of research performed by others.

In Canada ..... \$ \_\_\_\_\_

Outside Canada ..... \$ \_\_\_\_\_

NOTE. In Question 4 the company supports research performed by others whilst this research is being done. In Question 5(a) the reporting company pays only for information which it desires. The original research may have been sponsored by others.

(b) Total amount received in 1963 by the reporting company for patents, licences and technical "know-how" embodying the results of research performed by the reporting company.

In Canada ..... \$ \_\_\_\_\_

Outside Canada ..... \$ \_\_\_\_\_

For D.B.S. use only	6. Estimate the percentages of the 1963 total current cost of scientific R & D performed by the reporting company (Question 1) incurred in creating or improving products or processes in the following fields:		For D.B.S. use only
	Foods and beverages:	Transportation equipment:	
	Foods for human consumption ..... %	Aircraft and parts* ..... %	
	Animal feeds ..... %	Motor vehicles and parts ..... %	
	Beverages ..... %	Other transportation equipment ..... %	
	Tobacco products ..... %	Electrical products:	
	Rubber products ..... %	Electronic equipment ..... %	
	Textiles:	Other electrical products ..... %	
	Synthetic textiles ..... %	Non-metallic mineral products:	
	Other textiles ..... %	Cement and concrete ..... %	
	Paper products:	Other non-metallic mineral products ..... %	
	Newsprint ..... %	Petroleum and coal products:	
	Other paper products* ..... %	Petrochemicals ..... %	
	Other wood products ..... %	Other petroleum or coal products ..... %	
	Mining ..... %	Chemicals and chemical products:	
	Smelting and refining ..... %	Drugs and medicines ..... %	
	Rolling, casting and extruding ..... %	Industrial chemicals* ..... %	
	Fabricated metal products* ..... %	Mixed fertilizers ..... %	
	Machinery:	Plastics and synthetic resins ..... %	
	Agricultural machinery ..... %	Other chemicals or chemical products ..... %	
	Other machinery ..... %	Scientific and professional equipment* ..... %	
		Other (identify) ..... %	
	<b>NOTE.</b> The starred fields are described on page 6.		
For D.B.S. use only	7. Estimate the percentages of the 1963 total current costs of scientific R & D performed by the reporting company (Question 1) made in the following scientific fields:		For D.B.S. use only
	Aeronautical engineering ..... %	Geology, geophysics and other earth sciences ..... %	
	Chemical engineering ..... %	Metallurgy ..... %	
	Civil engineering ..... %	Physics ..... %	
	Electrical engineering ..... %	Agricultural sciences ..... %	
	Electronic engineering ..... %	Forestry ..... %	
	Mechanical engineering ..... %	Biological sciences ..... %	
	Mining engineering ..... %	Medicine ..... %	
	Other engineering (identify) ..... %	Pharmacy ..... %	
	..... %	Other (identify) ..... %	
	Chemistry ..... %	..... %	
	8. Estimate the percentages of the 1963 total current costs of scientific R & D performed by the reporting company (Question 1) made in the following areas:		For D.B.S. use only
	(a) Research and development for products and processes to be used in the investigation, production or use of nuclear energy ..... %		
	(b) Research and development for products and processes to be used in space travel and space communication ..... %		
	(c) Research and development for products and processes to be used for war and defence ..... %		
	(d) Research and development for products and processes to be used for civilian purposes ..... %		
	<b>NOTE.</b> Do not include any work in nuclear science or space travel in defence. All expenditures in nuclear science and space travel are to be considered when calculating the percentages asked for in 8(a) and 8(b). The total percentages must add to 100.		

9. Estimate the percentages of the 1963 total current costs of scientific R & D performed by the reporting company (Question 1) attributable to basic research, applied research, and development.

For D.B.S. use only

Basic research .....	_____ %
Applied research .....	_____ %
Development .....	_____ %

**NOTE.** Research is the process by which new understanding and new concepts are evolved. Basic research is research undertaken primarily for the advancement of scientific knowledge. Applied research is the same, but with a specific practical application in view. Development is the use of the results of scientific research in order to improve existing materials, devices, products or processes, or to produce new ones.

Research is generally relatively inexpensive compared to development.

Total percentages must add to 100.

10. Capital expenditures on new or extended facilities for use in R & D activities.

	Land	Buildings	Equipment	Total
	\$	\$	\$	\$
1961 .....				
1962 .....				
1963 .....				

11. Number of professional personnel (scientists, engineers and senior administrators) engaged in scientific R & D done within the reporting company in 1963 (estimate full-time equivalent if some persons work part time only on R & D).

Bachelor Level	Master's Degree	Doctorate		Bachelor Level	Master's Degree	Doctorate
			Aeronautical engineers			
			Chemical engineers			
			Civil engineers			
			Electrical engineers			
			Electronic engineers			
			Forestry engineers			
			Mechanical engineers			
			Mining engineers			
			Other engineers (identify)			
			Chemists			
			Food technologists			
			<b>Total</b>			
			Geologists and other earth scientists			
			Mathematicians			
			Metallurgists			
			Physicists			
			Agricultural scientists			
			Biological scientists			
			Medical scientists			
			Pharmacists			
			R & D administrators			
			Other (identify)			
			<b>Total</b>			

**NOTE.** Certain professional associations require members who are not university graduates to either pass qualifying examinations or to have a certain amount of professional experience and competence. Members of such associations, who do not have a university degree, are to be considered as being at the Bachelor level.

12. Estimate the percentages of the professional personnel employed in scientific R & D (Question 11) engaged in basic research, applied research and development.

For  
D.B.S.  
use  
only

Basic research ..... %  
 Applied research ..... %  
 Development ..... %

13. Number of supporting personnel engaged in scientific R & D done within the reporting company in 1963 (estimate full-time equivalent if some persons work part time only on R & D).

Technicians .....  
 Skilled craftsmen .....  
 Other supporting personnel .....

**NOTE.** Technicians are technical personnel having high school graduation or equivalent and additional technical training, who assist scientists and engineers in R & D (e.g. laboratory technicians and assistants, draftsmen). Skilled craftsmen are workers in positions requiring specialized training and experience and who are engaged in R & D (e.g. glassblowers, machinists, modelmakers). Other supporting personnel includes unskilled help, as well as persons such as clerks and typists who are involved in the management or administration of R & D. Persons employed in providing or maintaining a subsidiary service such as janitors or security personnel are excluded, even though expenditures on these services are included in the total current costs of R & D reported in Question 1.

14. Approximate 1963 sales of the reporting company (exclude sales of goods purchased for resale) ..... \$

15. Average 1963 employment of the reporting company .....

**NOTE.** If this is a consolidated return, please aggregate the sales and employment of all companies included in the report.

16. Estimate of R & D activity in future years.

(a) Total current cost of scientific R & D to be done within the reporting company in 1964 (comparable to Question 1) ..... \$

(b) 1964 payments in support of the scientific R & D performed by others (comparable to Question 4).

In Canada ..... \$

Outside Canada ..... \$

(c) Total capital expenditures in 1964 on new or extended facilities for R & D activities (comparable to Question 10) .....

Land	Buildings	Equipment	Total
\$	\$	\$	\$

(d) Professional personnel expected to be employed on R & D (comparable to Question 11)..... 1964 .....

if possible { 1965 .....  
 1966 .....

## DEFINITIONS

### 1. Scientific Research and Development

(a) Scientific R & D is investigative work carried out:

- (1) to acquire new knowledge,
- (2) to devise and develop new products or processes, or
- (3) to apply newly acquired knowledge in making improvements to existing products or processes.

When necessary to test a new or improved product or process, the design, construction and evaluation of a pilot plant or prototype are included in scientific R & D.

(b) Scientific R & D does NOT include:

- (1) research in the social or psychological sciences,
- (2) market research,
- (3) operations research (except when the design of mechanical systems is involved),
- (4) sales promotion,
- (5) quality control of products or materials or routine product testing,
- (6) prospecting, exploring or drilling for minerals, petroleum or natural gas, including geological, geophysical or related studies,
- (7) preparation of specifications and other engineering information required to enable construction of facilities for commercial production,
- (8) preparation, prior to commencement of commercial production, of instructions for the operation of facilities referred to in paragraph (7).

2. It is important to distinguish between **development** and **production**. Development ceases and production begins when the work or process becomes routine and is no longer experimental. For example, a pilot plant, once the original, investigative work is over, may be used as a production unit. Its operating costs can then no longer be considered development costs. Similarly, a research unit may spend a portion of its time on quality control or routine testing of raw materials. The effort devoted to such non-research activities cannot be attributed to R & D.

### 3. Product fields of Question 6

#### Other paper products:

Include all papers except newsprint; include paperboard, building papers and building board made of fibre pulps.

#### Fabricated metal products:

Include structural and architectural metal products; tanks; wire fencing, screening and netting; insulated wire and cable; hardware; valves and pipe fittings.

#### Aircraft and parts:

Include aircraft, airframes and aircraft engines; missiles and space satellites; major parts and components for aircraft, missiles and satellites. Individual electronic devices are considered **electronic equipment**; aeronautical instruments belong to the **scientific and professional equipment** product field.

#### Industrial chemicals:

Include basic industrial organic and inorganic chemicals (except **petrochemicals**); synthetic rubber and dyes.

#### Scientific and professional equipment:

Includes instruments and equipment such as navigational and measuring instruments, photographic equipment, laboratory and medical instruments and equipment. Electronic computers, data processors and control devices are included in **other electrical products**.









A-4. (a) The Federal Government allows any increase in expenditures for scientific research, over the base year of 1961, to be deducted from taxable income at the rate of 150%. Has this incentive affected the research activities of the reporting company? Yes  No

(b) If "Yes", please describe briefly the effect of this measure on the research programme.

.....  
.....  
.....  
.....  
.....

A-5. In what year did the reporting company first:

(a) Establish a unit for continuing scientific research? .....

(b) Purchase research information from others, on a continuing basis (excluding such items as scientific journals)? .....

A-6. Please indicate the present policy of the reporting company with respect to the patentable results of company research:

	Check (x):	
	Yes	No
(a) Has patentable results .....		
(b) Patents all results .....		
(c) Does not patent any results .....		
(d) Does not patent discoveries in its field of primary interest but patents discoveries in other fields .....		
(e) Patents some results on a basis other than that in A-6 (d) above .....		

A-7. Please indicate the present policy of the reporting company with respect to releasing research results to its affiliates:

	Check (x):	
	Yes	No
(a) Has affiliates .....		
(b) Allows affiliates gratuitous access to its research results* .....		
(c) Requires a fee from affiliated companies for research results .....		
(d) Does not give affiliates any special consideration in this matter .....		

\* Apart from published information available to the public, such as scientific and technical journals.

STATISTICS CANADA LIBRARY  
BIBLIOTHÈQUE STATISTIQUE CANADA



1010721719

200-13