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INDUSTRIAL RESEARCH AND DEVELOPMENT EXPENDITURES IN CANADA

1961

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PREFACE

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 fourth 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 program undertaken by Canadian industry in 1961 and provides an indication of the relative size of the 1962 expenditures.

The 1961 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, 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, 1963. *Dominion Statistician*

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DEFINITIONS[1]

1. For the purposes of the 1961 survey, firms were given the following "working" definition of R & D:

Industrial research and development comprises activities ranging from pure research intent upon obtaining new knowledge in the life and pnysical sciences, to conceiving and developing new products, new processes and major changes in products or processes, and bringing them to the stage of production. Such activities as market and sales research and process and quality control are excluded, as well as other special cases outlined below.

The following kinds of activity are included in the concept of industrial R & D:

(a) Laboratory scale activity.

(b) The design and operation of pilot plants or prototypes, provided the main purpose is one of the following:
   (1) To test experimental conclusions reached at the laboratory level.
   (2) To establish finished product formulas, specifications or standards.
   (3) To design special equipment required by a new or improved process.
   (4) To prepare operating instructions for use at the manufacturing level.

(c) The engineering activity necessary to advance the design of a product or a process from the laboratory to the stage where it can be turned over to a production unit. The design, construction and testing of full scale models prior to production is included, along with the development of designs for special manufacturing equipment and tools required.

(d) The preparation of drawings, formulas, specifications and manuals of instruction for the use of manufacturing units, all of which are based on the research activities.

The following activities are not included in the concept of industrial R & D:

(a) Market research and development, including statistical surveys of consumer preferences, estimates of possible markets, distribution outlets, etc.

(b) Development of advertising programs including sales promotion and demonstration of new products.

(c) Economic research and other research in the social sciences.

(d) Application for patents, including related legal work.

(e) Experimental work performed to provide additional information as required for the completion of patent litigation.

(f) Routine quality or quantity control of a process or products at the manufacturing level.

(g) Investigation and/or analytical work in connection with mechanical interruptions in production (*i.e.* trouble shooting).

(h) Work required for the minor modification of a specific product to meet the requirements of a specific customer.

(i) Assistance furnished at the manufacturing level to facilitate production in accordance with established formulas, instructions or finished product specifications. This includes the cost of printing blueprints and instruction manuals.

(j) Geological or geophysical exploration.

2. In this report the following terminology was used:

(a) Canadian firm—a firm operating in Canada. When possible, 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" would include several firms.

(d) Intra-mural expenditures—expenditures for work performed within the reporting company, *i.e.* the cost of R & D performed by reporting companies.

(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.

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[1] The questionnaire reproduced in Section III contains the more complete set of definitions provided for the guidance of the respondents.

INDUSTRIAL RESEARCH AND DEVELOPMENT EXPENDITURES IN CANADA 1961

SECTION I

General Review

The importance of reliable statistics on research and development activities within industrialized countries is becoming more and more evident. One use of such statistics is to provide the basis for forecasts of research trends and of the employment of a nation's scientific manpower. Based on these statistics, national and international comparisons of various activities and facets of research and development can also be made. Economists and others attempting to measure the productivity of research and development require accurate statistics, whilst business management is finding such statistics a useful aid when allocating company resources.

The present report is the fourth produced by the Dominion Bureau of Statistics. At present the survey is conducted every two years, but it is hoped that eventually industrial research and development can be measured annually. The method of survey is to contact all firms operating in Canada which the Bureau believes might be paying for, or conducting, research and development. Firms replying affirmatively are mailed a detailed questionnaire and the returns are processed at the Bureau. Based on indirect information, the Bureau prepares estimates for those firms which do not return the questionnaire. The information contained in this report represents the R & D activity of firms conducting or paying for research and development, including those government enterprises providing commercial goods or services. Government departments and agencies, as well as non-profit organizations, are excluded from this survey.

The 1961 survey of industrial R & D found that 523 of the surveyed firms were performing or financing research and development. In most cases some or all of the work was performed within the reporting company, although some firms relied exclusively on other organizations, Canadian and foreign. In 1959 only 471 firms reported some R & D expenditures, but the increase in the number of such firms reporting in 1961 is due largely to a more complete coverage of the smaller firms, rather than to a large number of firms engaging in R & D for the first time. Any change in the number of such firms reported in each survey is not as significant as might appear at first, since a very small, once-in-a-lifetime payment to another organization is sufficient to cause a firm to be counted in the survey of that year. The number of firms reporting R & D expenditures should continue to increase for some time as the Bureau's coverage of the smaller firms becomes more complete. As might be expected, a few large firms perform most of all Canadian R & D. Of the 523 having R & D expenditures (a very small proportion of the total number of Canadian firms), 16 accounted for 50% of the total intra-mural expenditures.

Summary of R & D Expenditures of Canadian Firms, 1955-61

Year	Canadian R & D				Payments for R & D done outside Canada	Total R & D expenditures	Firms reporting R & D expenditures
	Firms reporting expenditures in Canada	Intra-mural expenditures	Extra-mural expenditures	Total expenditures			
		$'000			$'000,000		
1955	..	51,386	1,891[1]	53,277[1]	12.2	65.5	377
1957	..	124,531	4,209	128,740	19.8	148.5	455
1959	432	96,590	3,285	99,875	21.7	121.6	471
1961	464	113,255	4,293	115,156[2]	31.2	146.4	523

[1] Grants-in-aid of research are not included.
[2] 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. In previous years the problem of double-counting was avoided by excluding such payments from the extra-mural expenditures shown in the tables.

.. Figures not available.

Surveyed firms reported a total expenditure on R & D of $146.4 million in 1961. This represents a substantial advance over the 1959 level—an increase of 20.4%. Payments for R & D performed outside Canada were 43.8% higher in 1961 than in 1959, and expenditures for Canadian R & D increased 15.2%. These increases are due mainly to larger R & D expenditures by the bigger firms, although the increased number of firms reporting has also been a cause. Another factor which contributes to a trend toward increased expenditures is the growth in the size of companies. As a company becomes larger or its R & D organization becomes more elaborate, it becomes practicable to establish

a more appropriate accounting system. This enables the company to allocate more exactly the indirect and overhead costs attributable to R & D. The trend toward greater R & D expenditures should continue in 1962, since firms indicated an increase of over $5 million in estimated intra-mural R & D costs.

Two industries showed a particularly noticeable increase in R & D activity between 1959 and 1961: the electrical products industry had intra-mural costs of $21,745,019, an increase of 36.7%, and the chemical and chemical products industry had costs of $20,251,461, an increase of 49.0%. The only significant decrease in R & D expenditures from 1959 to 1961 occurred in the transportation equipment industry, where intra-mural expenditures decreased 33.8%, to $19,856,661.

Source of Funds for Intra-mural R & D

Source	1957		1959		1961	
	Amount	Per cent	Amount	Per cent	Amount	Per cent
	$'000	%	$'000	%	$'000	%
Reporting company	43,680	39.1	63,442	65.7	78,989	69.8
Parent, affiliate or subsidiary	9,047	7.3	9,750	10.1	8,240	7.3
Government funds through:						
(a) Prime contracts[1]	49,459	39.7	19,150	19.8	14,179	12.5
(b) Procurement contracts[2]	12,081	9.7	1,958	2.0	4,009	3.5
Contract work for other companies	5,264	4.2	2,290	2.4	5,465	4.8
Other					2,373	2.1
Totals	**124,531**	**100.0**	**96,590**	**100.0**	**113,255**	**100.0**

[1] Prime contracts are contracts primarily for research and development up to and including the development and production of prototypes.

[2] Procurement contracts are orders for quantities of certain products or equipment, the production of which will require the contractor to perform the research and development necessary before the contracts can be fulfilled.

Continuing the trend noticed in 1959, industry supplied a greater proportion of the funds it spent on R & D than in previous years. At the same time, the proportion of such funds provided by the Federal Government decreased. It is worth noting the steady increase in industrial R & D when the amounts received through government contracts are eliminated. In contrast to the fluctuations shown by the intra-mural R & D expenditures in the table above, after government contracts are subtracted the same expenditures increase from year to year: from less than $50,000,000 in 1955 to $62,990,555 in 1957, then to $75,581,542 in 1959 and $95,067,051 in 1961. There has also been a change in the recipients of government contracts. Because of a decrease in contracts to the aircraft component of the transportation equipment industry, and an increase in government funds received by the electrical products industry, the latter now receives more than half of all Federal Government R & D payments to industry.

Payments Made for Extra-mural R & D, 1961

Recipient	Payments to other organizations in Canada		Payments to other organizations outside Canada	
	Amount	Per cent	Amount	Per cent
	$'000	%	$'000	%
Parent, affiliate or subsidiary companies	163	3.8	27,133	86.9
Commercial laboratories	268	6.3	480	1.5
Other companies	1,457	34.0	2,935	9.4
Educational institutions	92	2.1	10	–
Research institutions	959	22.3	388	1.2
Grants-in-aid of research	1,242	28.9	115	0.4
Governments	63	1.5	5	–
Other	49	1.1	150	0.5
Totals	**4,293**	**100.0**	**31,216**	**100.0[1]**

[1] Because of rounding, the figures given do not add to exactly 100.0.

Because of the adjustments to prevent double-counting in the figures given for extra-mural payments in the years before 1961, it is impossible to make comparisons between most items. The increase in the size of grants-in-aid of research may be noted, however. This item increased 75% between 1959 and 1961. In 1961 firms operating in Canada paid $27,133,000 for R & D to foreign parents, affiliates or subsidiaries, receiving $8,077,000 from such sources. On the other hand, the extent to which many Canadian firms have gratuitous access to the research results of associated foreign companies is known to be substantial, but cannot be measured in monetary terms.

Intra-mural R & D Expenditures, by Product Group

Recipient product group	1959		1961	
	Amount	Per cent	Amount	Per cent
	$'000	%	$'000	%
Chemicals (except drugs and medicines)	16,089	16.7	19,781	17.5
Aircraft and parts	23,601	24.4	17,831	15.7
Electronics	10,369	10.7	15,562	13.7
Primary metals	10,250	10.6	13,299	11.7
Electrical equipment	8,489	8.8	9,743	8.6
Machinery (except electrical)	3,597	3.7	6,212	5.5
Forest products – Pulp and paper	–	–	6,089	5.4
Petroleum and natural gas	2,271	2.4	4,935	4.4
Fabricated metals	2,653	2.7	2,836	2.5
Drugs and medicines	2,030	2.1	2,789	2.5
Motor vehicles and parts	1,536	1.6	1,682	1.5
Professional and scientific instruments	953	1.0	1,097	1.0
Forest products – Other than pulp and paper	–	–	937	0.8
Other	14,753	15.3	10,462	9.2
Totals	**96,590**[1]	**100.0**	**113,255**	**100.0**

[1] Because of rounding, the figures given do not add to exactly 96,590.

The decline in R & D expenditures on aircraft and parts apparent in 1959 continued in 1961. The chemical group of products now receives the largest amount of R & D funds, replacing the aircraft and parts group. If the influence of government contracts is removed, the importance of research and development to chemical products becomes even more evident. In 1961 most product groups received an absolute increase in R & D funds, with expenditures on the petroleum and natural gas group increasing 117%.

Personnel Employed on Intra-mural R & D

	1957	1959	1961
Professional personnel:			
(a) Engineers:			
Bachelor degree level	2,406	2,093	2,583
Master degree level	195	221	231
Doctor degree level	98	90	108
Sub-totals	**2,699**	**2,404**	**2,922**
(b) Scientists:			
Bachelor degree level	1,023	1,018	1,021
Master degree level	233	259	264
Doctor degree level	399	460	466
Sub-totals	**1,655**	**1,737**	**1,751**
Totals, professional personnel	**4,354**	**4,141**	**4,673**
Supporting personnel:			
Technicians	3,661	3,186	3,770
Skilled craftsmen	792	862	1,024
Other	2,672	1,760	2,365
Totals, supporting personnel	**7,125**	**5,808**	**7,159**
Total employment in industrial R & D in Canada	**11,479**	**9,949**	**11,832**

The number employed in industrial R & D increased substantially from 1959 to 1961, but the employment within different sub-groups did not change in the same way. In general, employment within the professional group is more stable than that of supporting personnel. Within the professional group itself the engineers show the greatest fluctuations in numbers employed, due almost entirely to changes at the bachelor degree level. The decrease in this group from 1957 to 1959 was due to reduced employment in the aircraft component of the transportation equipment industry. The increase in the number of bachelor degree engineers employed from 1959 to 1961 is due mainly to higher employment in the electrical products industry, although both the chemical and transportation equipment industries increased the number of engineers working in R & D. The number of supporting personnel employed in R & D has fluctuated quite violently over the period 1957 to 1961. As for the professional personnel, the transportation equipment industrial group, because of changes taking place in the aircraft industry, was the major factor in R & D employment fluctuation. The number of supporting personnel working on R & D in the transportation equipment group decreased by 2,090 or 75% from 1957 to 1959, and increased by 787 or 110% from 1959 to 1961. There were also substantial increases in both the electrical products and the chemical industries.

The differences in the importance of R & D to various industries can be illustrated by comparing R & D expenditures to sales. For every one hundred dollars of sales, firms making payments for Canadian R & D spent an average of 74 cents on research and development. These expenditures ranged from $2.67 in the case of the electrical products industry to seven cents for the wood industry. It should be noted, however, that two of the three industries having the highest such ratios, the electrical products and the transportation equipment industries, are also the major recipients of government prime contracts for R & D.

Even though the magnitudes of the R & D expenditure-sales ratios are considerably larger in the United States, approximately the same order of industries has been observed. The major exception to this generalization is textiles, in which there seems to be a greater relative use of research in Canada than in the United States.

Although research and development is inherently more costly in some industries requiring elaborate apparatus for experiments and pilot plants, R & D expenditure-sales ratios seem to indicate that certain industries, because of the nature of their products and competition, rely much more on industrial research than do others.

Annual intra-mural R & D cost-per-professional employed may be a useful guide for those planning new or expanded R & D programs, although figures for nuclear and space research might not be relevant. A comparison of this ratio for all industries in 1959 and 1961 shows an increase from $23,350 to $24,236 per professional. Most industries seem to have had higher R & D cost-per-professional ratios, but the figures and procedures are still too crude to rely on for comparing the ratios of an industry from year to year. As might be expected, in general the larger the firm the larger its research and development cost-per-professional.

In summary, the 1961 survey of industrial research and development in Canada indicates that both R & D expenditures and employment increased over the preceding surveyed year, 1959. During the entire period surveyed by the Bureau, 1955 to 1961, there has been an increase from year to year in the amount of R & D financed by industry itself. Since 1955 three industries have accounted for more than half of the total industrial R & D expenditures in Canada. These three industries are the transportation equipment, the electrical products and the chemical industries.

SECTION II

TABLE 1. R & D Expenditures in Canada, by Industry, 1959 and 1961

Industry	1959			1961		
	Intra-mural R & D expenditures	Canadian extra-mural payments	Total	Intra-mural R & D expenditures	Canadian extra-mural payments	Net Industrial R & D expenditures[3]
	dollars					
Mines, quarries and oil wells	4,907,029	208,729	5,115,758	6,727,567	505,082	7,064,245
Manufacturing:						
Food and beverages	1,793,626	169,140	1,962,766	2,784,502	109,549	2,879,051
Rubber	1,219,165	29,906	1,249,071	1,371,755	2,500	1,374,255
Textile	1,395,769	22,921	1,418,690	1,057,633	96,474	1,129,207
Wood	102,081	32,915	134,996	61,088	27,929	81,609
Furniture and fixtures	27,500	1,500	29,000	116,800	14,000	130,100
Paper and allied industries	6,571,953	105,715	6,677,668	7,003,047	699,169	7,069,843
Primary metal	6,626,528	174,094	6,800,622	7,488,118	147,287	7,593,438
Metal fabricating	1,724,907	14,749	1,739,656	2,182,490	32,602	2,183,490
Machinery	3,121,907	26,657	3,148,564	4,814,738	93,529	4,902,542
Transportation equipment	25,570,722	893,675	26,464,397	19,856,661	121,825	19,863,486
Electrical products	15,903,065	124,172	16,027,237	21,745,019	156,432	21,765,159
Non-metallic mineral products	1,353,830	54,148	1,407,978	1,357,936	12,682	1,368,618
Petroleum and coal products	3,761,700	684,000	4,445,700	5,038,500	1,180,650	5,102,150
Chemical and chemical products	14,133,296	296,849	14,430,145	20,251,461	718,576	20,970,037
Other manufacturing[1]	3,004,378	137,847	3,142,225	5,194,825	54,722	5,203,657
Transportation, storage, communication and other utilities	2,779,440	105,052	2,884,492	3,102,796	37,055	3,139,851
Other non-manufacturing[2]	2,593,485	202,085	2,795,570	3,100,363	283,175	3,335,488
Totals	**96,590,381**	**3,284,154**	**99,874,535**	**113,255,299**	**4,293,238**	**115,156,226**

[1] Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.
[2] Includes the construction industry, scientific and engineering services, and trade associations.
[3] 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. In previous years the problem of double-counting was avoided by excluding such payments from the extra-mural expenditures shown in the tables.

TABLE 2. Intra-mural R & D Expenditures in Canada, 1959 - 62

Industry	1959	1960[1]	1961	1962[1]
	dollars			
Mines, quarries and oil wells	4,907,029	5,168,654	6,727,567	6,388,903
Manufacturing:				
Food and beverages	1,793,626	1,971,900	2,784,502	3,335,989
Rubber	1,219,165	1,199,140	1,371,755	1,295,777
Textile	1,395,769	1,462,940	1,057,633	976,000
Wood	102,081	109,096	61,088	63,900
Furniture and fixtures	27,500	33,156	116,800	118,000
Paper and allied industries	6,571,953	6,822,565	7,003,047	7,084,784
Primary metal	6,626,528	7,557,460	7,488,118	8,069,250
Metal fabricating	1,724,907	1,810,820	2,182,490	2,144,350
Machinery	3,121,907	3,089,325	4,814,738	5,210,377
Transportation equipment	25,570,722	8,072,106	19,856,661	17,680,830
Electrical products	15,903,065	17,551,660	21,745,019	23,480,119
Non-metallic mineral products	1,353,830	1,444,771	1,357,936	1,527,780
Petroleum and coal products	3,761,700	4,224,000	5,038,500	6,304,000
Chemical and chemical products	14,133,296	12,818,696	20,251,461	21,260,933
Other manufacturing[2]	3,004,378	2,617,766	5,194,825	6,487,507
Transportation, storage, communication and other utilities	2,779,440	3,126,460	3,102,796	3,610,000
Other non-manufacturing[3]	2,593,485	2,600,840	3,100,363	3,239,850
Totals	**96,590,381**	**81,681,155**	**113,255,299**	**118,258,329**

[1] Estimates for the years 1960 and 1962 are based on the companies' intentions for these years.
[2] Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.
[3] Includes the construction industry, scientific and engineering services and trade associations.

TABLE 3. Source of Funds for Intra-mural R & D by Industry, 1959

Industry	Reporting company	Parent, affiliated and/or subsidiary companies	Government funds received through:		Others[1]	Total intra-mural R & D
			R & D prime contracts	R & D procurement contracts		
	dollars					
Mines, quarries and oil wells	4,817,385	27,000	–	–	62,644	4,907,029
Manufacturing:						
Food and beverages	1,588,587	205,039	–	–	–	1,793,626
Rubber	956,388	262,777	–	–	–	1,219,165
Textile	1,363,769	32,000	–	–	–	1,395,769
Wood	102,081	–	–	–	–	102,081
Furniture and fixtures	27,500	–	–	–	–	27,500
Paper and allied industries	4,463,779	868,918	22,294	–	1,216,962	6,571,953
Primary metal	3,085,863	3,467,217	38,400	21,120	13,928	6,626,528
Metal fabricating	1,683,446	19,561	19,500	2,400	–	1,724,907
Machinery	3,121,907	–	–	–	–	3,121,907
Transportation equipment	11,506,473	100,000	13,764,249	200,000	–	25,570,722
Electrical products	8,745,939	752,146	4,651,866	1,734,990	18,124	15,903,065
Non-metallic mineral products	676,060	677,770	–	–	–	1,353,830
Petroleum and coal products	1,939,719	1,821,981	–	–	–	3,761,700
Chemical and chemical products	13,556,529	495,811	17,396	–	63,560	14,133,296
Other manufacturing[2]	2,127,528	286,307	342,135	–	248,408	3,004,378
Transportation, storage, communication and other utilities	2,779,440	–	–	–	–	2,779,440
Other non-manufacturing[3]	899,913	733,140	294,489	–	665,943	2,593,485
Totals	**63,442,306**	**9,749,667**	**19,150,329**	**1,958,510**	**2,289,569**	**96,590,381**
Per cent distribution to total %	*65.7*	*10.1*	*19.8*	*2.0*	*2.4*	*100.0*

[1] Consists largely of other firms and organizations within the same industry which make payments to the reporting company for R & D, including those with R & D contracts with the reporting company.
[2] Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.
[3] Includes the construction industry, scientific and engineering services, and trade associations.

TABLE 4. Source of Funds for Intra-mural R & D by Industry, 1961

Industry	Reporting company	Parent, affiliated and/or subsidiary companies	Government funds received through:		Contract work for other companies	Others[1]	Total intra-mural R & D
			R & D prime contracts	R & D procurement contracts			
	dollars						
Mines, quarries and oil wells	5,286,827	521,536	35,000	–	822,204	82,000	6,727,587
Manufacturing:							
Food and beverages	2,444,402	340,100	–	–	–	–	2,784,502
Rubber	1,367,055	–	4,700	–	–	–	1,371,755
Textile	1,037,633	20,000	–	–	–	–	1,057,633
Wood	60,338	750	–	–	–	–	61,088
Furniture and fixtures	116,800	–	–	–	–	–	116,800
Paper and allied industries	4,443,637	863,219	35,200	–	190,991	1,470,000	7,003,047
Primary metal	5,040,118	2,440,000	–	–	–	8,000	7,488,118
Metal fabricating	2,101,195	2,700	70,595	8,000	–	–	2,182,490
Machinery	4,778,258	36,480	–	–	–	–	4,814,738
Transportation equipment	12,237,694	111,900	6,377,229	400,000	529,838	200,000	19,856,661
Electrical products	10,478,918	239,720	6,870,541	2,594,740	1,561,100	–	21,745,019
Non-metallic mineral products	1,321,936	36,000	–	–	–	–	1,357,936
Petroleum and coal products	3,178,500	1,783,000	–	–	77,000	–	5,038,500
Chemical and chemical products	19,305,358	767,364	178,739	–	–	–	20,251,461
Other manufacturing[2]	2,452,244	42,000	464,181	1,006,100	1,230,300	–	5,194,825
Transportation, storage, communication and other utilities	3,012,796	–	–	–	90,000	–	3,102,796
Other non-manufacturing[3]	345,395	1,035,000	143,223	–	963,527	613,218	3,100,363
Totals	**78,989,104**	**8,239,769**	**14,179,408**	**4,008,840**	**5,464,960**	**2,373,218**	**113,255,299**
Per cent distribution to total %	*69.8*	*7.3*	*12.5*	*3.5*	*4.8*	*2.1*	*100.0*

[1] Consists largely of other firms and organizations within the same industry which make payments to the reporting company for R & D.
[2] Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.
[3] Includes the construction industry, scientific and engineering services and trade associations.

TABLE 5. Intra-mural R & D Expenditures, by Industry, by Field of Research,[1] 1961

Industry	Engineering						
	Aeronautical	Chemical	Civil	Electrical	Electronic	Mechanical	Other
	dollars						
Mines, quarries and oil wells	–	818,598	–	–	–	131,600	952,276
Manufacturing:							
Food and beverages	–	529,612	–	–	–	52,333	19,010
Rubber	–	132,500	–	2,758	5,518	52,174	–
Textile	–	260,100	–	–	–	55,900	–
Wood	–	–	1,250	–	–	300	36,060
Furniture and fixtures	–	–	–	–	–	17,000	65,000
Paper and allied industries	–	1,150,505	90,000	7,780	33,840	686,633	33,607
Primary metal	–	17,765	6,250	–	–	162,425	–
Metal fabricating	–	6,000	37,823	357,006	11,550	862,921	635,180
Machinery	–	1,359	–	271,348	17,250	4,165,885	298,592
Transportation equipment	15,920,336	71,300	–	156,340	230,962	2,077,289	799,180
Electrical products	126,000	39,459	–	3,376,340	12,309,824	1,096,986	45,897
Non-metallic mineral products	–	123,459	9,125	62,442	41,662	60,958	104,459
Petroleum and coal products	–	803,120	–	–	–	251,040	292,880
Chemical and chemical products	–	5,210,574	–	65,940	48,430	1,017,425	594,155
Other manufacturing[2]	330,080	44,441	–	1,050,771	1,042,489	1,180,483	43,550
Transportation, storage, communication and other utilities	–	380,072	175,250	1,268,626	416,910	467,878	28,634
Other non-manufacturing[3]	50,000	146,808	17,798	17,812	87,624	303,458	45,925
Totals	**16,426,416**	**9,735,672**	**337,496**	**6,637,163**	**14,246,059**	**12,642,488**	**3,994,405**
Per cent distribution to total ..... %	*14.5*	*8.6*	*0.3*	*5.9*	*12.6*	*11.2*	*3.5*

Industry	Science							
	Chemistry	Physics	Geology, geophysics and other earth sciences	Metallurgy	Medicine	Agriculture	Other	Total
	dollars							
Mines, quarries and oil wells	344,200	235,000	225,727	3,973,886	–	10,400	35,880	6,727,567
Manufacturing:								
Food and beverages	1,233,966	3,823	–	–	–	499,991	445,767	2,784,502
Rubber	590,871	70,464	–	–	–	–	517,470	1,371,755
Textile	398,821	31,200	–	–	16,850	–	294,962	1,057,633
Wood	750	–	–	500	–	8,528	13,700	61,088
Furniture and fixtures	–	–	–	–	–	–	34,800	116,800
Paper and allied industries	2,357,097	943,503	4,514	–	–	–	1,895,568	7,003,047
Primary metal	–	26,470	158,820	7,116,388	–	–	–	7,488,118
Metal fabricating	5,000	–	–	251,854	–	–	15,156	2,182,490
Machinery	–	–	–	14,564	–	45,740	–	4,814,738
Transportation equipment	2,607	3,910	90,000	453,237	–	–	51,500	19,856,661
Electrical products	317,101	932,902	–	509,828	–	–	2,990,682	21,745,019
Non-metallic mineral products	119,255	127,162	107,900	39,757	–	–	561,757	1,357,936
Petroleum and coal products	3,022,020	–	585,760	–	–	83,680	–	5,038,500
Chemical and chemical products	9,119,703	530,300	–	130,240	2,575,658	40,000	919,038	20,251,461
Other manufacturing[2]	384,360	319,286	159,315	14,450	–	–	625,800	5,194,825
Transportation, storage, communication and other utilities	–	71,585	28,834	248,311	–	–	17,096	3,102,796
Other non-manufacturing[3]	456,925	114,184	48,936	1,443,100	–	56,000	311,793	3,100,363
Totals	**18,352,678**	**3,409,789**	**1,409,606**	**14,196,115**	**2,592,306**	**744,339**	**8,530,769**	**113,255,299**
Per cent distribution to total ..... %	*16.2*	*3.0*	*1.2*	*12.5*	*2.3*	*0.7*	*7.5*	*100.0*

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

TABLE 6. Intra-mural R & D Expenditures, by Industry, by Product Group, 1961[1]

Industry	Aircraft and parts	Chemicals (except drugs and medicines)	Drugs and medicines	Electrical equipment (except electronics)	Electronics	Fabricated metals	Forest products, pulp and paper
	dollars						
Mines, quarries and oil wells	–	527,405	–	39,000	470,000	190,750	–
Manufacturing:							
Food and beverages	–	216,505	210,867	1,950	–	650	–
Rubber	10,349	539,861	10,350	17,850	10,350	–	31,048
Textile	–	410,421	49,950	–	–	–	35,000
Wood	–	–	–	–	–	2,500	–
Furniture and fixtures	–	–	–	–	–	66,200	–
Paper and allied industries	–	409,209	–	–	–	–	5,593,438
Primary metal	19,966	15,508	–	–	–	325,530	–
Metal fabricating	–	–	–	503,156	–	1,197,552	–
Machinery	–	26,350	–	234,146	3,550	181,700	15,555
Transportation equipment	16,042,320	7,821	–	434,889	40,642	308,790	–
Electrical products	–	92,694	300	7,194,311	13,869,961	161,831	–
Non-metallic mineral products	–	–	–	–	–	4,073	2,521
Petroleum and coal products	–	635,210	–	–	–	–	–
Chemical and chemical products	15,000	16,100,616	2,517,971	65,940	–	97,100	390,000
Other manufacturing[2]	1,893,457	97,619	–	537,870	785,582	90,958	21,438
Transportation, storage, communication and other utilities	–	–	–	712,500	237,500	–	–
Other non-manufacturing[3]	50,000	701,417	–	1,500	144,184	208,120	–
Totals	**17,831,092**	**19,780,636**	**2,789,438**	**9,743,112**	**15,561,769**	**2,835,754**	**6,089,000**
Per cent distribution to total %	*15.7*	*17.5*	*2.5*	*8.6*	*13.7*	*2.5*	*5.4*

Industry	Forest products other than pulp and paper	Machinery (except electrical)	Motor vehicles and parts	Petroleum and natural gas	Primary metals	Professional and scientific instruments	Others	Total
	dollars							
Mines, quarries and oil wells	–	1,334	–	503,812	4,607,875	19,000	368,391	6,727,567
Manufacturing:								
Food and beverages	–	8,450	–	–	–	–	2,346,080	2,784,502
Rubber	–	31,048	528,571	10,349	10,349	–	171,630	1,371,755
Textile	–	–	–	–	–	–	582,262	1,057,633
Wood	58,088	–	–	–	500	–	–	61,088
Furniture and fixtures	–	–	–	–	–	–	50,600	116,800
Paper and allied industries	782,045	–	5,500	–	–	–	212,855	7,003,047
Primary metal	–	–	–	–	6,985,204	35,000	106,910	7,488,118
Metal fabricating	–	446,604	–	–	4,156	–	31,022	2,182,490
Machinery	3,550	3,870,094	396,726	9,900	8,264	–	64,903	4,814,738
Transportation equipment	–	1,292,518	652,917	–	10,000	300,000	766,764	19,856,661
Electrical products	–	15,000	–	1,500	–	–	409,422	21,745,019
Non-metallic mineral products	–	–	92,036	–	12,605	–	1,246,701	1,357,936
Petroleum and coal products	–	–	–	4,403,290	–	–	–	5,038,500
Chemical and chemical products	65,000	255,240	5,000	5,000	71,810	32,500	630,284	20,251,461
Other manufacturing[2]	10,000	95,427	1,225	–	–	710,160	1,151,089	5,194,825
Transportation, storage, communication and other utilities	–	–	–	–	–	–	2,152,796	3,102,796
Other non-manufacturing[3]	18,497	196,500	–	1,500	1,588,596	–	190,049	3,100,363
Totals	**937,180**	**6,212,215**	**1,681,975**	**4,935,351**	**13,299,359**	**1,096,660**	**10,461,758**	**113,255,299**
Per cent distribution to total %	*0.8*	*5.5*	*1.5*	*4.4*	*11.7*	*1.0*	*9.2*	*100.0*

[1] 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, must be classified under only one industry.

[2] Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.

[3] Includes the construction industry, scientific and engineering services and trade associations.

TABLE 7. Capital Expenditures on New Facilities for Use in R & D Activities, 1959 and 1961

Industry	Capital expenditures for research facilities	
	1959	1961
	dollars	
Mines, quarries and oil wells	388,955	642,011
Manufacturing:		
Food and beverages	228,800	273,863
Rubber	50,000	80,700
Textile	116,100	41,200
Wood	–	–
Furniture and fixtures	–	–
Paper and allied industries	401,761	408,429
Primary metal	1,374,907	1,371,427
Metal fabricating	13,000	216,000
Machinery	117,265	183,135
Transportation equipment	1,431,764	594,040
Electrical products	1,063,461	1,356,603
Non-metallic mineral products	562,800	660,985
Petroleum and coal products	4,244,673	2,027,550
Chemical and chemical products		2,281,513
Other manufacturing[1]	298,752	415,229
Transportation, storage, communication and other utilities	69,350	1,770,000
Other non-manufacturing[2]	330,297	170,843
Totals	**10,691,885**	**12,493,528**

[1] Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.
[2] Includes the construction industry, scientific and engineering services and trade associations.

TABLE 8. Number and Classes of R & D Personnel, by Industry, 1961

Industry	Level of training			Total professional personnel	Level of training			Total supporting personnel	Supporting personnel per professional personnel
	Bachelor	Master	Doctorate		R & D technicians	Skilled craftsmen	Other supporting personnel		
Mines, quarries and oil wells	213	25	11	249	187	26	59	272	1.1
Manufacturing:									
Food and beverages	89	28	40	157	103	20	52	175	1.1
Rubber	52	5	12	69	56	8	23	87	1.3
Textile	32	10	6	48	59	8	26	93	1.9
Wood	4	–	1	5	1	2	2	5	1.0
Furniture and fixtures	7	–	–	7	–	12	2	14	2.0
Paper and allied industries	169	36	89	274	177	52	269	498	1.8
Primary metal	198	33	40	271	455	13	129	597	2.2
Metal fabricating	73	5	–	78	64	47	19	130	1.7
Machinery	95	7	–	102	149	157	94	400	3.9
Transportation equipment	738	42	14	794	622	206	675	1,503	1.9
Electrical products	902	101	37	1,040	701	245	414	1,360	1.3
Non-metallic mineral products	48	4	5	57	58	9	36	103	1.8
Petroleum and coal products	82	17	39	138	139	33	35	207	1.5
Chemical and chemical products	556	113	240	909	741	86	303	1,130	1.2
Other manufacturing[1]	182	27	11	220	114	50	75	239	1.1
Transportation, storage, communication and other utilities	104	31	12	147	68	2	58	128	0.9
Other non-manufacturing[2]	64	12	32	108	76	48	94	218	2.0
Totals	**3,608**	**496**	**569**	**4,673**	**3,770**	**1,024**	**2,365**	**7,159**	**1.5**

[1] Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.
[2] Includes the construction industry, scientific and engineering services and trade associations.

TABLE 9. Professional Personnel Engaged in R & D, by Field and Level of Training, 1959 and 1961

Field of training	1959					1961				
	Level of training			Total	Per cent	Level of training			Total	Per cent
	Bachelor	Master	Doctorate			Bachelor	Master	Doctorate		
	number				%	number				%
Professional personnel:										
Engineers – Aeronautical						370	13	10	393	8.4
Chemical	408	70	53	531	12.8	424	68	41	533	11.4
Civil	38	13	2	53	1.3	48	5	2	55	1.2
Electrical	654	64	17	735	17.8	567	60	14	641	13.7
Electronic						455	47	8	510	10.9
Mechanical	623	46	9	678	16.4	527	30	21	578	12.4
Other	370	28	9	407	9.8	198	8	6	212	4.5
Totals, engineers	**2,093**	**221**	**90**	**2,404**	**58.1**	**2,589**	**231**	**102**	**2,922**	**62.5**
Chemists	491	126	272	889	21.5	568	126	284	978	20.9
Physicists	119	40	53	212	5.1	55	44	45	144	3.1
Geologists, geophysicists, and other earth scientists	15	9	7	31	0.7	34	6	13	53	1.1
Metallurgists	206	26	20	252	6.1	190	31	21	242	5.2
Mathematicians	25	7	2	34	0.8	28	11	1	40	0.9
Medical scientists	19	13	44	76	1.8	16	11	29	56	1.2
Agricultural scientists	18	2	5	25	0.6	28	7	10	45	1.0
Administrators (of R & D)	92	27	47	166	4.0	68	22	49	139	3.0
Other	33	9	10	52	1.3	32	7	15	54	1.1
Totals, professional personnel	**3,111**	**480**	**550**	**4,141**	**100.0**	**3,608**	**496**	**569**	**4,673**	**100.0**

TABLE 10. Professional Personnel Engaged in R & D, by Industry and by Field of Training, 1961

Industry	Engineering							Chemists
	Aero-nautical	Chemical	Civil	Electrical	Electronic	Mechanical	Other	
	number							
Mines, quarries and oil wells	–	62	3	1	1	7	39	38
Manufacturing:								
Food and beverages	–	32	–	–	–	5	1	71
Rubber	–	22	–	–	1	1	–	44
Textile	–	9	–	1	–	10	6	18
Wood	–	–	1	–	–	1	1	1
Furniture and fixtures	–	–	–	–	–	1	6	–
Paper and allied industries	–	53	1	–	–	19	8	159
Primary metal	–	35	4	10	–	25	14	38
Metal fabricating	–	3	5	8	4	38	7	1
Machinery	2	–	–	4	1	79	6	–
Transportation equipment	350	11	13	114	72	136	47	1
Electrical products	4	13	9	386	374	116	22	23
Non-metallic mineral products	–	16	5	1	–	3	11	3
Petroleum and coal products	–	26	1	2	2	–	16	67
Chemical and chemical products	24	220	3	13	–	42	7	459
Other manufacturing[1]	12	8	2	33	32	59	17	26
Transportation, storage, communication and other utilities	–	13	8	66	21	17	–	–
Other non-manufacturing[2]	1	10	–	2	2	19	4	29
Totals	**393**	**533**	**55**	**641**	**510**	**578**	**212**	**978**

TABLE 10. Professional Personnel Engaged in R & D, by Industry and by Field of Training, 1961 – Concluded

	Physicists	Geologists, geophysicists and other earth scientists	Metallurgists	Mathematicians	Medical scientists	Agricultural scientists	Administrators	Other	Total
	number								
Mines, quarries and oil wells	7	18	59	2	–	3	6	3	249
Manufacturing:									
Food and beverages	3	–	–	–	5	28	4	8	157
Rubber	1	–	–	–	–	–	–	–	69
Textile	1	–	–	–	1	–	2	–	48
Wood	–	–	–	–	–	–	1	–	5
Furniture and fixtures	–	–	–	–	–	–	–	–	7
Paper and allied industries	6	–	–	5	–	5	13	5	274
Primary metal	27	11	88	–	–	–	11	8	271
Metal fabricating	–	–	7	1	–	–	4	–	78
Machinery	1	1	5	–	–	–	3	–	102
Transportation equipment	3	2	23	11	–	–	11	–	794
Electrical products	51	–	21	1	–	–	20	–	1,040
Non-metallic mineral products	5	2	1	2	–	–	2	6	57
Petroleum and coal products	5	16	–	–	–	1	2	–	138
Chemical and chemical products	25	–	10	7	50	3	31	15	909
Other manufacturing[1]	5	–	3	9	–	1	12	1	220
Transportation, storage, communication and other utilities	1	2	10	1	–	1	6	1	147
Other non-manufacturing[2]	3	1	15	1	–	3	11	7	108
Totals	**144**	**53**	**242**	**40**	**56**	**45**	**139**	**54**	**4,673**

[1] Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.
[2] Includes the construction industry, scientific and engineering services and trade associations.

TABLE 11. Number of Canadian Firms Making R & D Expenditures, 1961

Industry	Firms conducting intra-mural R & D[1]	Firms paying for extra-mural R & D only[2]	Total
	number		
Mines, quarries and oil wells	35	13	48
Manufacturing:			
Food and beverages	34	14	48
Rubber	7	3	10
Textile	10	5	15
Wood	9	5	14
Furniture and fixtures	5	–	5
Paper and allied industries	25	11	36
Primary metal	17	6	23
Metal fabricating	32	4	36
Machinery	46	5	51
Transportation equipment	27	1	28
Electrical products	51	3	54
Non-metallic mineral products	20	6	26
Petroleum and coal products	4	4	8
Chemical and chemical products	48	8	56
Other manufacturing[3]	26	5	31
Transportation, storage, communication and other utilities	5	8	13
Other non-manufacturing[4]	15	6	21
Totals	**416**	**107**	**523**

[1] Such firms may or may not have extra-mural expenditures as well.
[2] Includes companies paying for R & D performed both in Canada and/or abroad.
[3] Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.
[4] Includes the construction industry, scientific and engineering services and trade associations.

TABLE 12. Dollars Spent on Canadian R & D in 1961 per One Hundred Dollars of Sales, by Industry[1]

Industry	Expenditures
Electrical products	2.67
Chemical and chemical products	1.49
Transportation equipment	1.47
Machinery	1.10
Rubber	1.08
Textile	1.01
Other manufacturing[2]	0.98
Mines, quarries and oil wells	0.91
Non-metallic mineral products	0.75
Metal fabricating	0.69
Furniture and fixtures	0.67
Paper and allied industries	0.45
Primary metal	0.44
Petroleum and coal products	0.35
Food and beverages	0.16
Transportation, storage, communication and other utilities	0.14
Wood	0.07
Totals, all industries[3]	**0.74**

[1] Includes only those firms reporting payments for research and development performed in Canada (464 firms).
[2] Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.
[3] Except for non-manufacturing industries other than transportation, storage, communication and other utilities.

TABLE 13. Intra-mural R & D Expenditures per Professional, by Industry, 1959 and 1961

Industry	Expenditures	
	1959[1]	1961
	dollars	
Mines, quarries and oil wells	19,550	27,018
Manufacturing:		
Food and beverages	17,246	17,736
Rubber	17,368	19,881
Textile	19,120	22,034
Wood	11,342	12,238
Furniture and fixtures	13,750	16,686
Paper and allied industries	20,410	25,559
Primary metal	24,634	27,631
Metal fabricating	34,498	27,981
Machinery	33,212	47,203
Transportation equipment	34,369	25,008
Electrical products	20,336	20,909
Non-metallic mineral products	18,546	23,823
Petroleum and coal products	29,620	36,511
Chemical and chemical products	19,203	22,279
Other manufacturing[2]	17,777	23,613
Transportation, storage, communication and other utilities	19,037	21,108
Other non-manufacturing[3]	20,915	28,707
Totals, all industries	**23,350**	**24,236**

[1] In a few cases the 1959 figures differ from those derived from published figures for professionals and intra-mural R & D expenditures. This is due to a number of firms being placed in different industrial groups since the 1959 survey.
[2] Includes tobacco and tobacco products, leather products, clothing and knitting mills, and miscellaneous manufacturing industries.
[3] Includes the construction industry, scientific and engineering services and trade associations.

SECTION III

Coverage

Industrial research and development signifies the R & D performed or financed by the business enterprise sector of the economy. Business enterprises, based on their activities or products, can be grouped in a number of industries. Each of these industries uses R & D to a different extent, and is usually interested in different fields of research.

It was felt that some industries (as defined by *Standard Industrial Classification Manual*), because of the nature of their activities, would not be involved in research and development. These industries were: Agriculture, Forestry, Fishing and Trapping, Printing and Publishing, Trade, Finance, Insurance, Real Estate, the Community, Business and Personal Service Industries (except for the Engineering and Scientific Service and Trade Associations), and Public Administration. Non-profit and educational institutions are not covered, nor are the non-business types of government organizations.

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 preparing food and beverage materials for consumption.

Tobacco products

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

Rubber

Companies primarily engages 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.

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 associations are also included.

CONFIDENTIAL

Department of Trade and Commerce

in co-operation with The National Research Council

Dominion Bureau of Statistics
Business Finance Division
OTTAWA, CANADA

INDUSTRIAL RESEARCH-DEVELOPMENT EXPENDITURES 1961

Please correct any mistakes in name and address

Taken in Conformity with the Requirements of the Statistics Act Chap. 257 of the Revised Statutes of Canada, 1952

PURPOSE AND DEFINITIONS: See Pages 3 and 4.

NOTES: (a) Returns in this survey are confidential and individual company figures will not be identified.
(b) Mail one copy of this report within 6 weeks of receipt of the questionnaire to: Business Finance Division, Dominion Bureau of Statistics, Ottawa.
(c) Complete schedule as fully as possible. Your best estimates will be satisfactory if precise figures are not available.
(d) In the case of parent-subsidiary operations, a consolidated return covering all companies which are within the organization will be satisfactory.

1. If this report is a consolidated return, please list names and addresses of companies covered in this report:

Name	Address
.....	.....
.....	.....
.....	.....

2. Average number of persons employed by reporting company in all its activities in Canada during 1961 ..... No. _____

3. Total value of sales or services rendered by reporting company during 1961 (Estimate only) ..... $_____

4. If the reporting company has access to the results of industrial research-development done outside the company for which no payment is made, please give name and address of the organizations providing this service.

Name	Address
.....	.....
.....	.....
.....	.....

5. **Total cost of industrial research-development done within your company in Canada in 1961** ..... $_____

6. Source of funds for industrial research-development as reported in 5 above. Approximate amounts are acceptable. (see also Question 14).

(a) Reporting company ..... $_____

(b) Parent, affiliated and subsidiary companies ..... $_____

(c) Government funds received through:

(i) Industrial research-development prime contracts ..... $_____

(ii) Industrial research-development part of procurement contracts ..... $_____

(d) Contract work for other companies (see also Question 14) ..... $_____

(e) Others (please specify) ..... $_____

..... $_____

TOTAL FUNDS (same as Question 5) ..... $_____

7. Payments for industrial research-development not included in 5 above. (see also Question 15).

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 industrial research-development contracts	$_____	$_____
(e) Research institutions and foundations as industrial research-development contracts	$_____	$_____
(f) Grants for general research to educational and research institutions and foundations (see also Question 16)	$_____	$_____
(g) Governments	$_____	$_____
(h) Others (please specify)	$_____	$_____
TOTAL	$	$

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8. Source of funds for industrial research-development as reported in 7 above:

(a) Reporting company ..... $_____

(b) Others (please specify) ..... $_____

TOTAL ..... $_____

9. Estimated industrial research-development expenditures expected to be made by reporting company during 1962.

	In Canada	Outside Canada
(a) To be done within your company in Canada. Total expenditures for the year 1962, comparable to Question 5, above	$_____	x x x x x
(b) Payments for industrial research-development not included in 9(a). Total expenditures for the year 1962, comparable to Question 7, above	$_____	$_____

10. Indicate approximate percentage of total 1961 industrial research-development expenditures as reported in Question 5, made in each of the following scientific fields:

Engineering, Aeronautical ..... ____%	Engineering, Mechanical ..... ____%	Metallurgy ..... ____%
Engineering, Chemical ..... ____%	Engineering, Other ..... ____%	Medicine ..... ____%
Engineering, Civil ..... ____%	Chemistry ..... ____%	Agriculture ..... ____%
Engineering, Electrical ..... ____%	Physics ..... ____%	Others (please specify) ..... ____%
Engineering, Electronic ..... ____%	Geology, Geophysics and Other Earth Sciences ..... ____%	..... ____%

11. Indicate the approximate percentage of total 1961 industrial research-development costs, as reported in Question 5, the results of which are to be used in the manufacture of products in the following **industrial groups.** SEE DEFINITION ON PAGES 3 and 4.

Aircraft and Parts ..... ____%	Fabricated Metals ..... ____%	Petroleum and Natural Gas ..... ____%
Chemicals (except Drugs and Medicines) ..... ____%	Forest Products – Pulp and Paper ..... ____%	Primary Metals ..... ____%
Drugs and Medicines ..... ____%	Forest Products – Other than Pulp and Paper ..... ____%	Professional and Scientific Instruments ..... ____%
Electric Equipment (except Electronics) ..... ____%	Machinery (except Electrical) ..... ____%	Others (please specify) ..... ____%
Electronics ..... ____%	Motor Vehicles and Parts ..... ____%	..... ____%

12. Estimated capital expenditures during 1961 on new or extended facilities, including special building and equipment, for use in industrial research-development activities ..... $_____

13. Number of persons employed in industrial research-development done within your company organization during 1961 (full-time equivalent if part-time staff engaged). Include all persons whose pay is included in cost figures in Question 5.

(a) Industrial research-development scientists and engineers. All classes of supporting personnel are to be included in Part (b).

Bachelor Level	Master Level	Doctorate Level			Bachelor Level	Master Level	Doctorate Level
			..... Engineers, Aeronautical	Physicists			
			..... Engineers, Chemical	Geologists, geophysicists and other earth scientists			
			..... Engineers, Civil	Metallurgists			
			..... Engineers, Electrical	Mathematicians			
			..... Engineers, Electronic	Medical scientists			
			..... Engineers, Mechanical	Agricultural scientists			
			..... Engineers, Other	Administrators (of Research-Development) ..			
			..... Chemists	Other (please specify)			

(b) Supporting personnel – SEE DEFINITIONS on page 4

(i) Industrial research-development technicians ..... _____

(ii) Skilled craftsmen ..... _____

(iii) Other supporting personnel ..... _____

14. If industrial research-development was done on behalf of other companies or organizations in 1961 for which you were reimbursed, please give names and addresses. (see also Question 6).

Name	Address
.....	.....
.....	.....
.....	.....

15. If expenditures were made for industrial research-development outside the company in 1961, please give names and addresses of the organizations which undertook the research-development. (see also Question 7).

Name	Address
.....	.....
.....	.....
.....	.....

16. If funds were granted during 1961 to educational institutions, research institutions, foundations and hospitals for general research, please give names and addresses of these organizations. (see also Question 7(f)).

Name	Address
.....	.....
.....	.....
.....	.....

Name and Address of person making this report

Name _____ Official Position _____

Address _____ Date of this report _____ 1962

PURPOSE OF SURVEY

This survey of industrial research-development expenditures is being conducted in cooperation with the National Research Council and will provide information concerning the magnitude and direction of the industrial research-development program in Canada. There is a growing awareness in Canada of the essential role that an industrial research-development program performs in the economy. Comprehensive statistics must be available to industry and government to study the adequacy of current programs and for formulation of policies that will develop the research potential of Canada.

A survey of Industrial Research-Development Expenditures was carried out for the year 1959. The resulting publication, INDUSTRIAL RESEARCH-DEVELOPMENT EXPENDITURES IN CANADA, 1959, is available from the Queen's Printer, or from Publications Section, Dominion Bureau of Statistics, Ottawa under Catalogue No. 13-516 for 75 cents.

DEFINITIONS

A. CONCEPT OF INDUSTRIAL RESEARCH-DEVELOPMENT:

Industrial research-development comprises activities ranging from pure research intent upon obtaining new knowledge in the life and physical sciences, to conceiving and developing new products, new processes and major changes in products or processes, and bringing them to the stage of production. Such activities as market and sales research and process and quality control are excluded, as well as other special cases outlined below. In case of doubt, please feel free to ask about special situations which you may encounter.

The following kinds of activity are to be included in the concept of industrial research-development:

1. Laboratory scale activity.
2. The design and operation of pilot plants or prototypes, provided the main purpose is one of the following:
   (a) To test experimental conclusions reached at the laboratory level.
   (b) To establish finished product formulas, specifications or standards.
   (c) To design special equipment required by a new or improved process.
   (d) To prepare operating instructions for use at the manufacturing level.
3. The engineering activity necessary to advance the design of a product or a process from the laboratory to the stage where it can be turned over to a production unit. The design, construction and testing of full scale models prior to production is included, along with the development of designs for special manufacturing equipment and tools required.
4. The preparation of drawings, formulas, specifications and manuals of instruction for the use of manufacturing units, all of which are based on the research activities. (See No. 9 in the following section).

The following activities are NOT to be included in the concept of industrial research-development:

1. Market research and development, including statistical surveys of consumer preferences, estimates of possible markets, distribution outlets, etc.
2. Development of advertising programs including sales promotion and demonstration of new products.
3. Economic research and other research in the social sciences.
4. Application for patents, including related legal work.
5. Experimental work performed to provide additional information as required for the completion of patent litigation.
6. Routine quality or quantity control of a process or products at the manufacturing level.
7. Investigation and/or analytical work in connection with mechanical interruptions in production (i.e. trouble shooting).
8. Work required for the minor modification of a specific product to meet the requirements of a specific customer.
9. Assistance furnished at the manufacturing level to facilitate production in accordance with established formulas, instructions or finished product specifications. This includes the cost of printing blueprints and instruction manuals. (See No. 4 in preceding section).
10. Geological or geophysical exploration.

DEFINITIONS CONCLUDED ON PAGE 4

B. COST OF INDUSTRIAL RESEARCH-DEVELOPMENT:

Include all costs incurred for industrial research-development work done.

If you maintain a separate industrial research-development organization, include all operating costs of this organization minus an estimated allowance of the cost of non-research technical services as outlined (Nos. 1 to 10) in the preceding section. Include also an estimate of the cost of industrial research-development work done by company divisions or technicians not part of the industrial research-development organization. Exclude capital expenditures as part of current industrial research-development costs, but include in this cost Item 12. Costs incurred as a result of industrial research-development activity within your company organization may include but are not limited to the following:

1. Wages, salaries and related costs, including "fringe benefits", of all research personnel, including scientists and all classes of supporting staff.

2. Materials and supplies used (or purchased), including the cost of purchasing, receiving, inspection, storage and transportation.

3. Literature purchased to provide background information necessary for research operations.

4. Company overhead, which is an **estimated** share of the functions supporting industrial research-development activity.

If industrial research-development operations are being conducted for your company by outside organizations, enter the cost in Section 6. Your entries should include the total charges for the work including professional fees and administrative costs.

C. DEFINITION OF INDUSTRIAL GROUPS AS NOTED IN ITEM 11:

Aircraft and Parts:

Research and development related to piloted and unpiloted aircraft and parts of all types such as engines, landing gear, propellers, turrets and all auxiliary equipment specifically adapted for aircraft, including guided missiles. Radar and radar equipment and other electronic devices for aircraft should be included with electronics, and aeronautical instruments should be included with professional and scientific instruments.

Chemicals (except Drugs and Medicines):

Research and development related to organic and inorganic chemicals including petro-chemicals, primary plastics, synthetic fibres, explosives, soaps and glycerines, paints and varnishes and other products of a chemical nature.

Drugs and Medicines:

Research and development related to medical and pharmaceutical preparations. This includes patent and preparatory medicines, veterinary medicines, vitamin products and biological products, such as antitoxins, bacterins, serums, vaccines, etc.

Electrical Equipment (except Electronics):

Research and development related to systems machinery, apparatus and supplies for generation, storage, transmission and transformation and utilisation of electrical energy, except those of an essentially electronic nature.

Electronics:

Research and development related to electronic systems and components, whether for wire and wireless telephone and telegraph of all kinds, radio and television transmitting and receiving, object detection, industrial controls and business machines.

Fabricated Metals:

Research and development related to fabricated metal products such as fabricated structural metal products, metal stamping, pressing and coating, hardware, tools and cutlery, fabricated wire products and non-electric heating apparatus. Exclude machinery and transportation equipment.

Forest Products:

Research-development related to all forest products including wood, lumber, pulp and paper.

Machinery (except Electrical):

Research and development related to machinery and movers other than electrical equipment, including engines and turbines, agricultural, construction and mining machinery, metal working machinery and other special and general industrial machinery and equipment. Exclude motor vehicles and other transportation equipment.

Motor Vehicles and Parts:

Research and development related to motor vehicles including passenger automobiles, commercial cars and buses, trucks and truck trailers, universal carriers, and special purpose motor vehicles such as ambulances, fire engines, etc.

Petroleum and Natural Gas:

Research and development related to petroleum and natural gas. Petro-chemicals should be included under **chemicals** above. Geological and Geophysical activities are NOT to be reported.

Primary Metals:

Research and development related to smelting, refining, rolling, drawing, extruding and alloying of metals and the manufacture of castings, forgings and other basic metal products.

Professional and Scientific Instruments:

Research and development related to professional and scientific instruments and equipment, including surveyors, nautical, navigational and aeronautical instruments; instruments for laboratory work and scientific research; surgical, dental and medical instruments; electric and mechanical measuring instruments and surgical supplies; and photographic equipment and supplies.

D. SUPPORTING PERSONNEL: (See Question 13(b))

Technicians:

Technical personnel having high school graduation or equivalent and additional technical training, who assist scientists and engineers in industrial research-development work (i.e. laboratory technicians and assistants, draftsmen, etc.).

Skilled Craftsmen:

Workers in positions requiring specialized training and experience and who are engaged in industrial research-development work (i.e. glassblowers, machinists, modelmakers, etc.).

Other Supporting Personnel:

All other persons whose pay is included in Item 5.