Communications Canada

INDUSTRIAL RESEARCH AND DEVELOPMENT STATISTICS FOR COMMUNICATIONS AND INFORMATION TECHNOLOGIES

TECHNOLOGY, POLICY AND PLANNING BRANCH

INDUSTRIAL RESEARCH AND DEVELOPMENT STATISTICS FOR COMMUNICATIONS AND INFORMATION TECHNOLOGIES

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JUNE, 1989.

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Secretary

HIGHLIGHTS

* Communications and Information Technologies (C&IT) research and development (R&D) expenditures have grown substantially from $142 million in 1975 to $1,445 million in 1987.

* C&IT R&D expenditures have grown faster than total industrial R&D expenditures from 1975 to 1987. C&IT accounted for 40% of all industrial R&D expenditures in 1987, compared to only 22% in 1975.

* The dominant source of C&IT R&D funding in 1986 is the performing firm, accounting for 58% of all funding. Foreign sources are the second largest source of funds (24%). The federal government accounted for 7% of all financing.

* Over 70% of all C&IT R&D expenditures occur in Ontario.

* Ontario, Quebec, and British Columbia accounted for 97% of all C&IT R&D expenditures, and 96% of all personnel engaged in C&IT R&D in 1986.

* Out of the ~~644~~ 613 firms that carried out C&IT R&D in 1986, the top 4 firms (or 1% of the total number of firms) were responsible for over 50% of the C&IT R&D performed.

* The telecommunication equipment industry is the major performer within C&IT R&D, accounting for 45% of all expenditures in 1987. Business machines and computer services accounted for 30% of all C&IT R&D expenditures.

* Canadian ~~owned~~ controlled C&IT firms outperformed foreign ~~owned~~ controlled firms, spending 6.5% of sales on R&D in 1986, while foreign ~~owned~~ controlled firms spent 4.4%.

* The telecommunication equipment and computer service sectors are dominated by Canadian ~~owned~~ controlled firms, who perform the majority of R&D.

* In business machines, despite the fact that 90% of R&D performers are Canadian ~~owned~~ controlled, they perform only 30% of the R&D.

* The number of persons engaged in C&IT R&D doubled between 1981 and 1986 to reach 17,250. Professionals represented 59% of the total personnel engaged in C&IT R&D in 1986.

* Overall, Canada had a positive balance of payments for C&IT technological services in 1986, primarily because of the telecommunication equipment industries.

INTRODUCTION

Statistics Canada has collected extensive data on research and development (R&D) for decades, and publishes a series of related surveys. Some statistics for communications and information technologies (C&IT) are provided in various R&D publications, such as "Industrial Research and Development Statistics" (catalogue 88-202). For example we know that the telecommunications equipment industry accounted for 19% of all industrial R&D in 1987.

Given the significance of the C&IT sector to the economy, and its predominance in R&D it was felt that more detailed information was needed for C&IT. It should be noted that the publication "Industrial Research and Development Statistics" devotes a special section to R&D within the energy sectors. A similar emphasis for C&IT seems warranted.

The Department of Communications asked Statistics Canada to produce statistics specifically for R&D in C&IT industries. Sectors included in the definition of C&IT industries for the purpose of this report include:

1980 SIC CODE	INDUSTRY
3351	Telecommunication equipment
3352	Electronic parts and components
3359	Other electronic equipment
3361 & 3362	Electronic computing and peripherals, and electronic office store and business machines
4821 & 4839	Telecommunication carriers and operators
7721	Computer services
7722	Computer equipment maintenance and repair

Statistics Canada produced a special computer run from its Industrial R&D statistics for the Department of Communications, based on our request. The information contained in this report on industrial R&D in the C&IT industries is based completely on this Statistics Canada data.

This report is based on responses from 644 C&IT research performers with estimated R&D expenditures of $1,445 million in 1987. Average expenditures for a performing firm were $2.4 million in 1986, ranging from $200,000 for small firms to $38.5 million for firms with sales over $100 million. In 1986 17,250 people were employed in C&IT R&D. This represents 37% of all R&D personnel. Ontario, Quebec, and British Columbia accounted for 96% of all personnel engaged in C&IT R&D, and 97% of all expenditures.

Table I

SUMMARY OF INDUSTRIAL C&IT R&D EXPENDITURES

Current Dollars

Year	Current intramural expenditures	Capital expenditures	Total intramural expenditures	Current expenditures in 1981 dollars
1975	142	11	153	234
1976	155	14	169	236
1977	186	12	198	266
1978	214	18	232	288
1979	255	31	286	313
1980	323	41	363	358
1981	465	78	543	465
1982	638	94	732	587
1983	741	151	892	649
1984	877	201	1,078	743
1985	1,104	225	1,328	907
1986	1,263	209	1,472	1,007
1987(e)	1,445	258	1,704	1,103

Source: Stat. Canada, C&IT Statistics

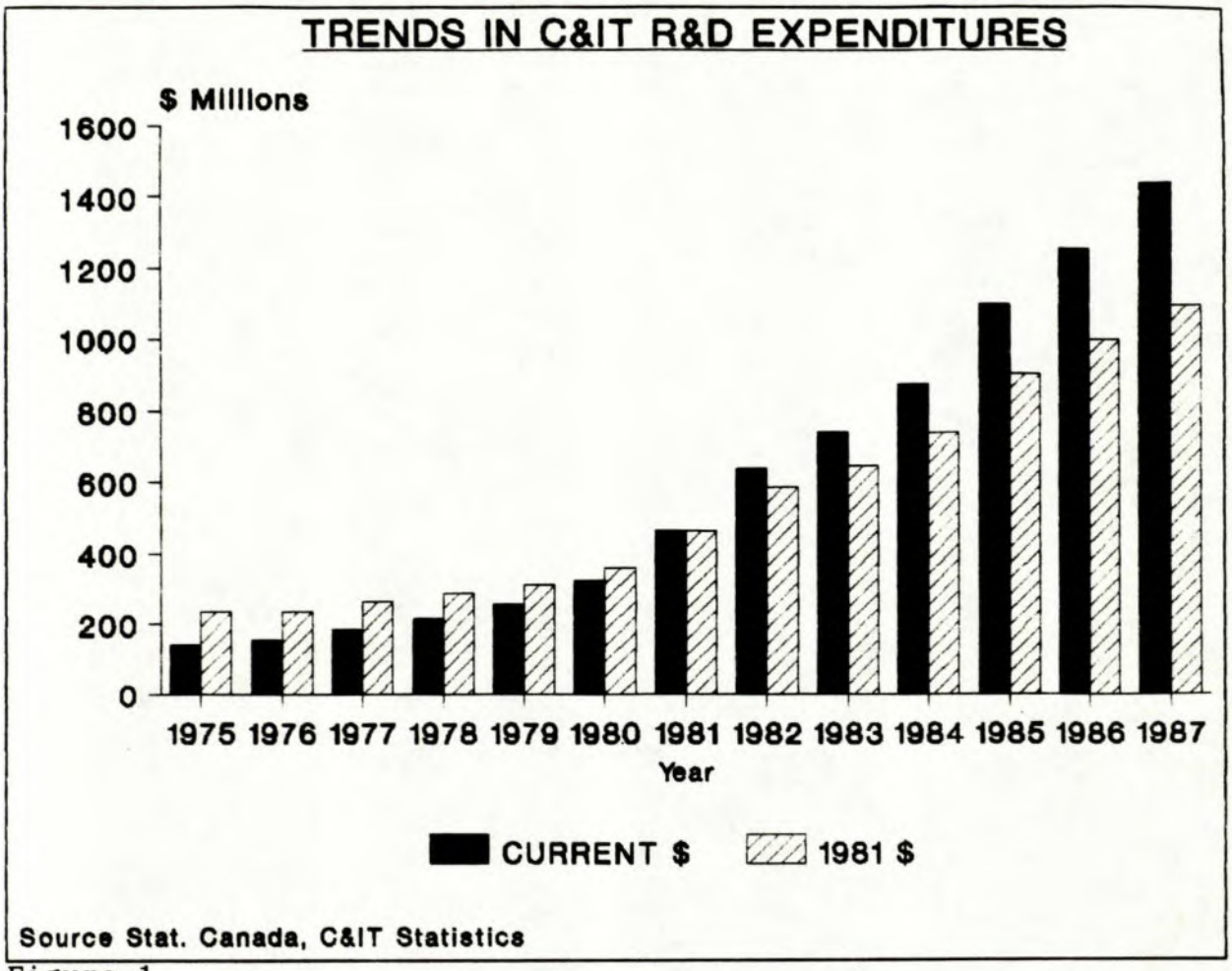

Figure 1

* Research and Development (R&D) is defined as a systematic investigation carried out in the natural and engineering sciences by means of experiment or analysis to acheive a scientific or commercial advance.

* Expenditures in this graph refer to expenditures made by a firm within Canada on wages and consumables, and exclude expenditures on capital items. These are refered to as "current intramural expenditures" and are considered a better indicator of trends in R&D expenditures. Capital expenditures vary greatly and do not reflect the level of R&D being performed.

* Industrial C&IT research and development expenditures have grown substantially from $142 million in 1975 to $1,445 million in 1987.

* Current intramural expenditures increased by 918% during the period 1975 to 1987. Expressed in 1981 dollars, this increase is 475% over the ten year period.

Table II

SUMMARY OF INDUSTRIAL, AND C&IT, R&D EXPENDITURES 1975 - 1987

Current Expenditures In 1981 Dollars

Year	Total R&D (millions of dollars)	C&IT R&D
1975	1,041	234
1977	1,124	266
1979	1,316	313
1981	1,846	465
1983	1,975	649
1985	2,503	907
1987(e)	2,765	1,103

Source: Stat. Canada, C&IT Statistics

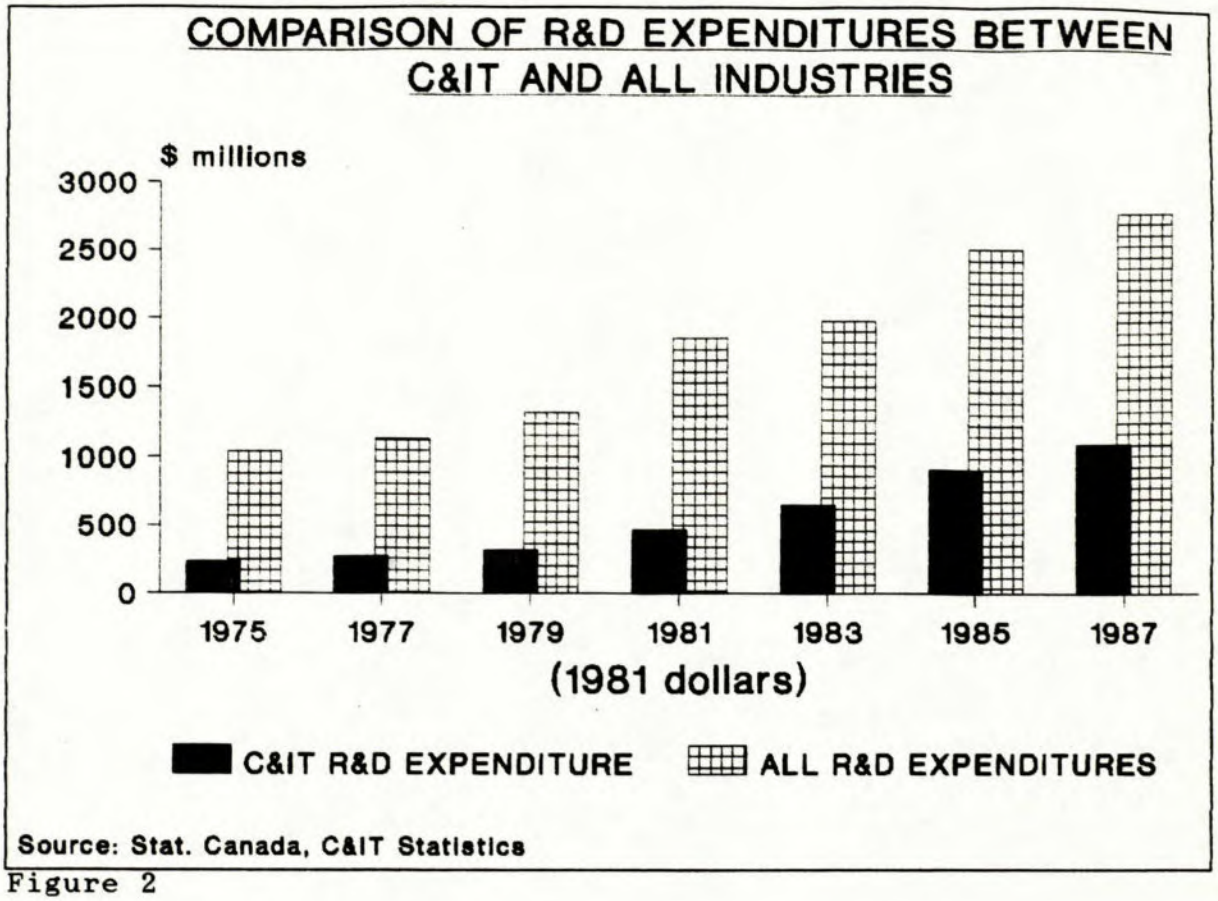

Figure 2

* C&IT research and development expenditures have grown faster than total industrial research and development expenditures during the period 1975 to 1987.

* While total industrial intramural expenditures (expressed in 1981 dollars) have increased by 166% during 1975 to 1987, communication and information technology research and development has increased by ~~176%~~ 371% during this same period.

* Communication and information technology R&D expenditures accounted for 40% of all research and development expenditures in 1987, compared to only 22% in 1975.

Table III

SOURCE OF FUNDS FOR INTRAMURAL C&IT R&D, 1986

Sources Of Funds	C&IT R&D performers		All R&D performers	
	(millions of dollars)			
Internal	858	(58%)	2,464	(64%)
Parent, affiliated and subsidiary companies	105	(7%)	234	(6%)
Federal Government	100	(7%)	409	(11%)
Provincial Governments	10	(1%)	53	(1%)
R&D contract work for others	31	(2%)	111	(3%)
Other Canadian (ie: university)	11	(1%)	42	(1%)
Foreign (excluding foreign parent company)	357	(24%)	515	(14%)
Total	**1,472**	**(100%)**	**3,828**	**(100%)**

Source: Stat. Canada, C&IT Statistics

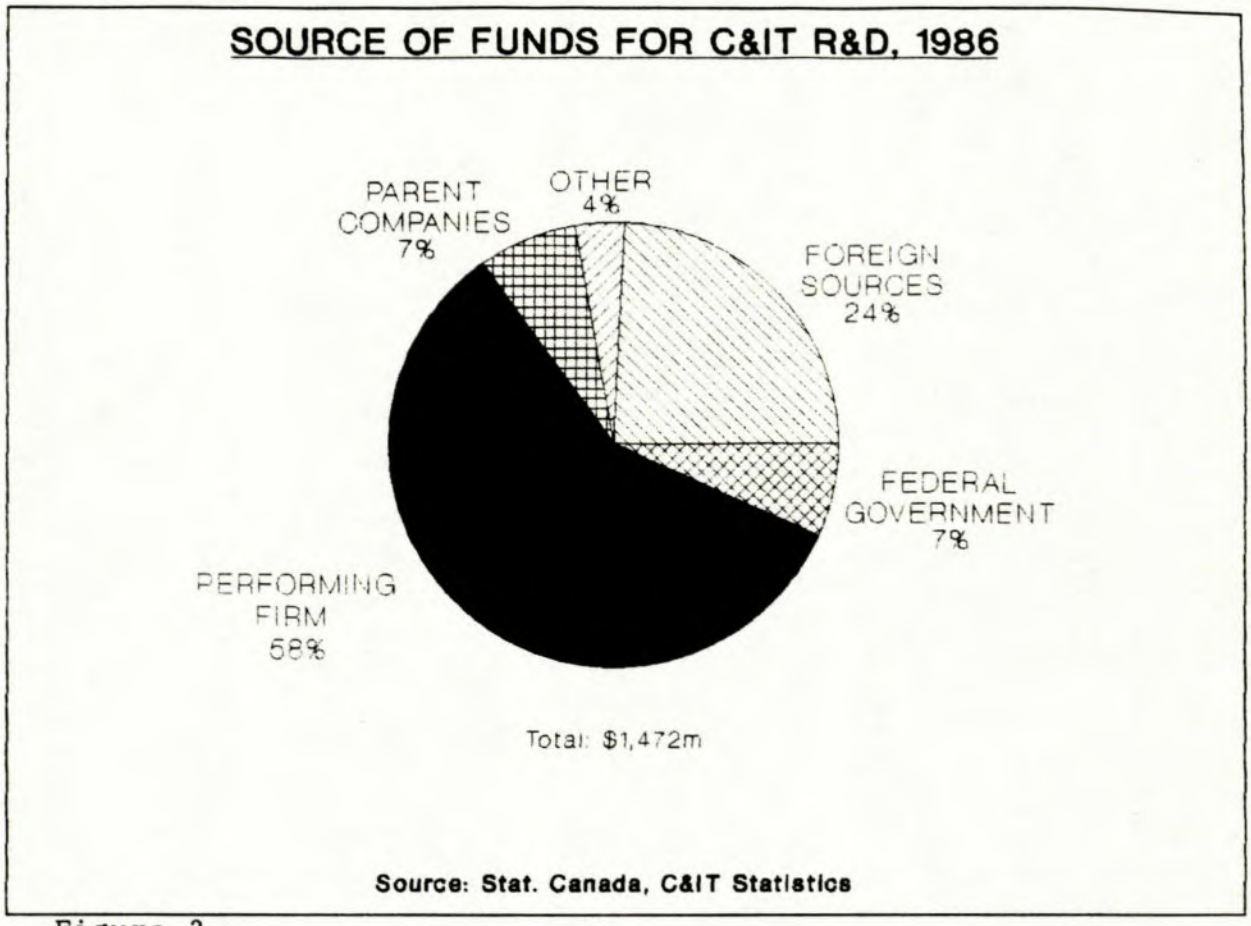

Figure 3

* The dominant source of R&D funding is the performing firm, accounting for 58% of all financing. In comparison, the percentage of funds originating from the performing company is 64% for industrial R&D for all firms.

* Foreign sources are the second largest origin of funds, financing 24% of intramural R&D in 1986. This percentage is considerably higher than the 14% financed by foreign sources for industrial R&D for all firms. This discrepancy may be partly explained by the presence of business machines within the C&IT category, which receive 50% of their R&D funding from foreign sources.

* Federal Government financing accounted for 7% of C&IT R&D funding. This compares to the Government's 11% contribution to aggregate industrial R&D funding.

* Financing originating from a performing firm's ~~parent~~ affiliated company accounted for 7% of C&IT R&D funding. Other contributions include 1% from provincial governments, 1% from universities, and 2% from firms providing R&D contracts.

Table IV

C&IT R&D COMPANIES BY PROVINCE, 1986

Province	Number of R&D Companies	
Atlantic Provinces	18	(3%)
Quebec	133	(21%)
Ontario	307	(48%)
Manitoba	9	(1%)
Saskatchewan	21	(3%)
Alberta	53	(8%)
British Columbia	103	(16%)
Total	644	(100%)

Source: Stat. Canada, C&IT Statistics

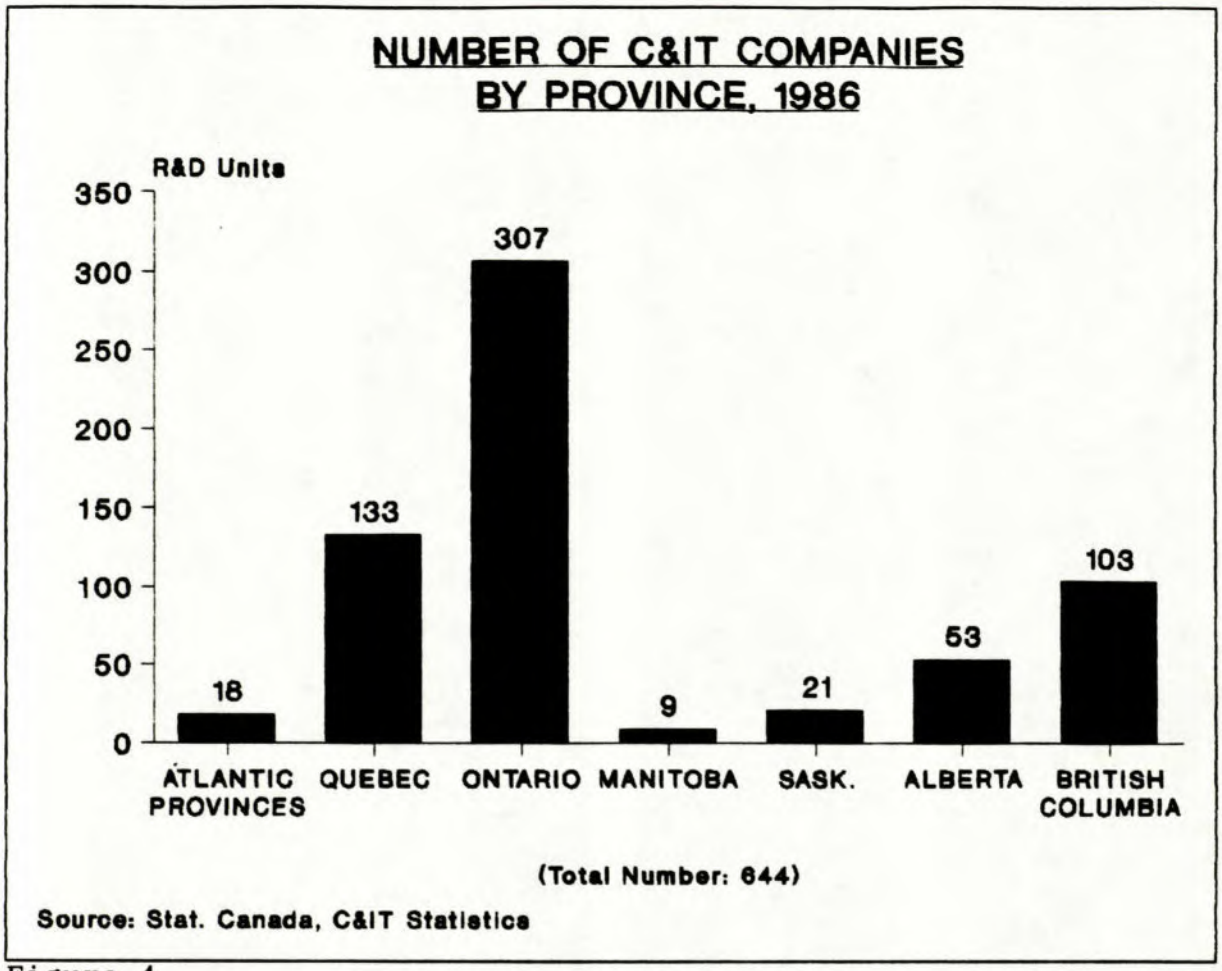

Figure 4

* R&D companies are heavily concentrated in Ontario (with 48% of the total), Quebec (21%), and British Columbia (16%).

* These three provinces account for 85% of all C&IT R&D companies, 97% of all C&IT R&D expenditures, and 96% of all personnel engaged in C&IT R&D.

Table V

REGIONAL DISTRIBUTION OF INTRAMURAL C&IT R&D EXPENDITURES, 1986

Region	Current expenditures	Capital expenditures	Total expenditures
	(millions of dollars)		
Atlantic Provinces	8	1	9
Quebec	202	26	228
Ontario	925	165	1,090
Manitoba	1		1
Saskatchewan	13	2	15
Alberta	18	3	21
British Columbia	97	11	108
Total	1,263	209	1,472

Source: Stat. Canada, C&IT Statistics

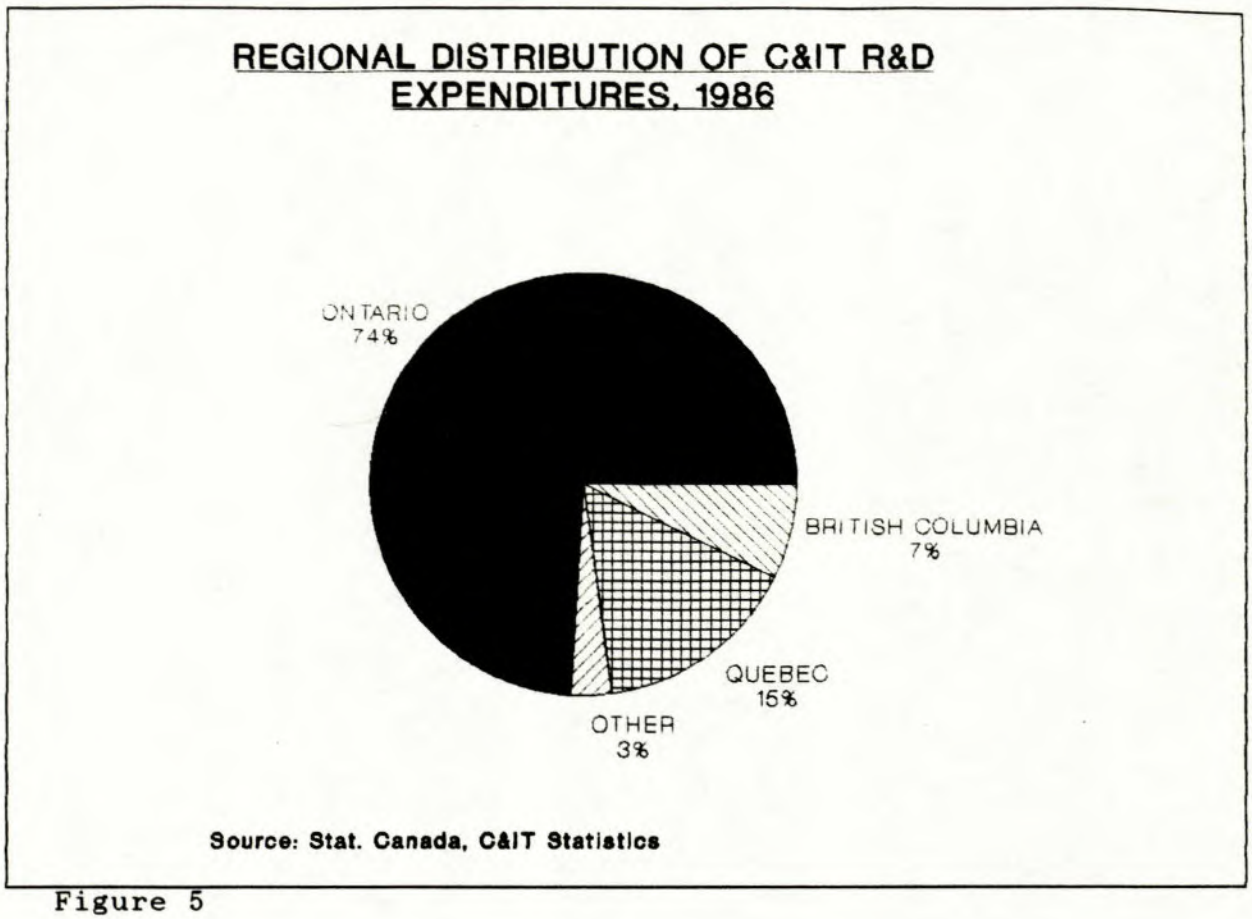

Figure 5

* C&IT R&D expenditures are heavily concentrated in Ontario, which undertakes 74% of all expenditures. Ontario's dominance can be partially explained by the strong presence of the telecommunications equipment industry in the province.

* British Columbia, Quebec, and Ontario accounted for 97% of total C&IT R&D expenditures during 1986.

Table VI

CONCENTRATION OF INDUSTRIAL C&IT R&D AMONG COMPANIES, 1975, 1981, 1986

Year	Top 4	Top 10	Top 25	Top 50	Total Intramural Expenditures
		(companies)			
	(percent of total expenditures)				($000,000)
1975	67	81	92	97	153
1981	53	71	87	94	543
1986	53	69	79	87	1,472

Source; Stat. Canada, C&IT Statistics

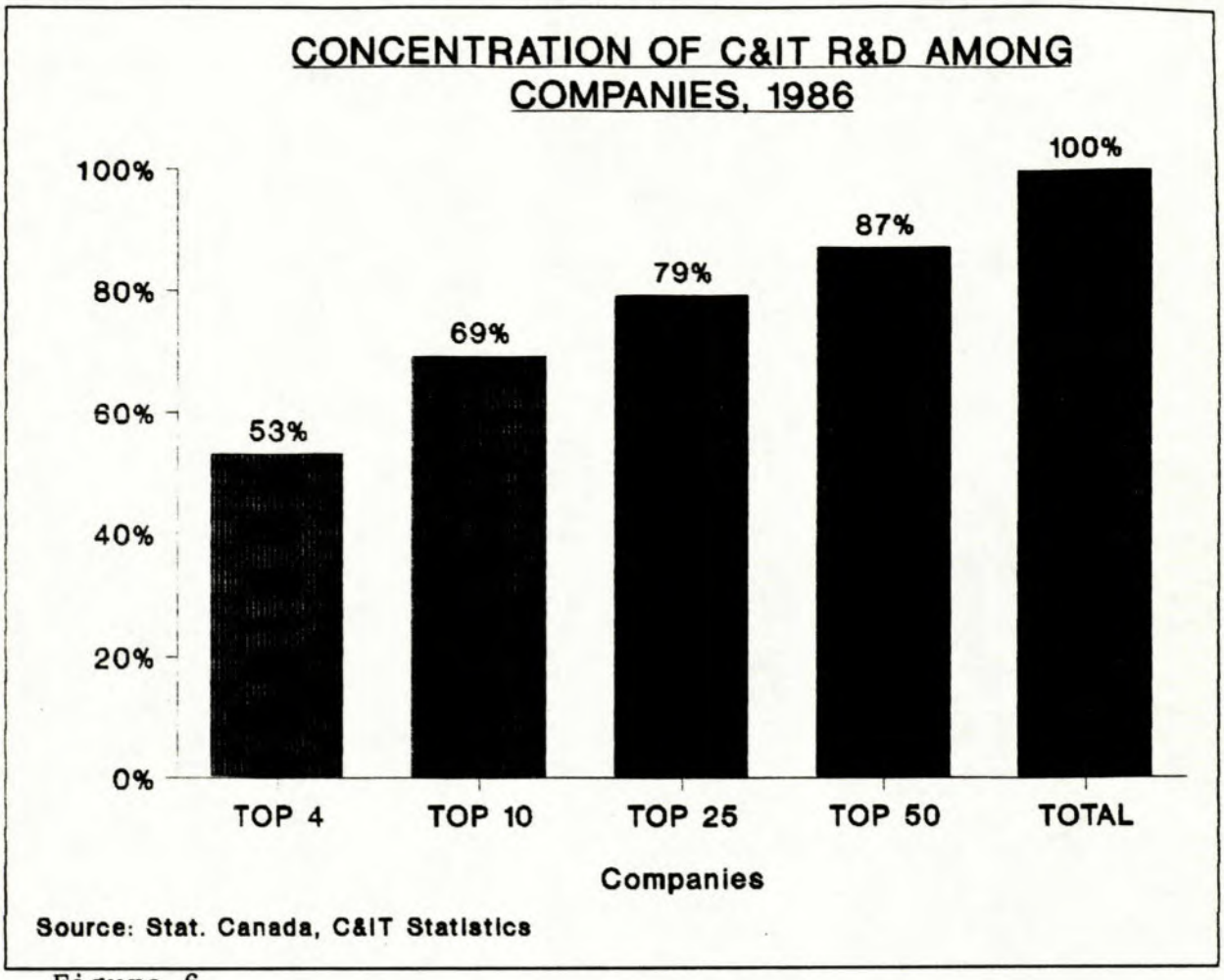

Figure 6

* From the 644 companies performing C&IT R&D in 1986, the top 4 firms (or 1% of the total) were responsible for over one half of all intramural R&D expenditures.

* C&IT R&D was less heavily concentrated in 1986 than in 1975. In 1975 the top four firms accounted for almost 70% of all C&IT R&D, compared to 53% in 1986.

* The top 25 firms (or 4% of the total 644) were responsible for almost 80% of intramural R&D expenditures. C&IT R&D appears to be more heavily concentrated than total industrial R&D, in which the top 100 firms (or 3% of the total 3,414 firms) accounted for 67% of the R&D performed.

Table VII

CONCENTRATION OF INDUSTRIAL C&IT R&D AMONG INDUSTRIES, 1983 TO 1987

C&IT industries	1983	1984	1985	1986	1987
	(percent of total intramural expenditures)				
Telecommunication equipment	51	49	46	42	45
Electronic parts & components	3	3	3	2	2
Other electronic equipment	17	17	19	20	17
Electronic computing and peripherals, and electronic office, store and business machines	15	15	14	15	18
Telecommunication carriers and operators	8	7	7	8	6
Computer services	6	9	11	13	12
	(total in millions of dollars)				
Total	892	1,078	1,328	1,472	1,704

Source Stat. Canada, C&IT Statistics

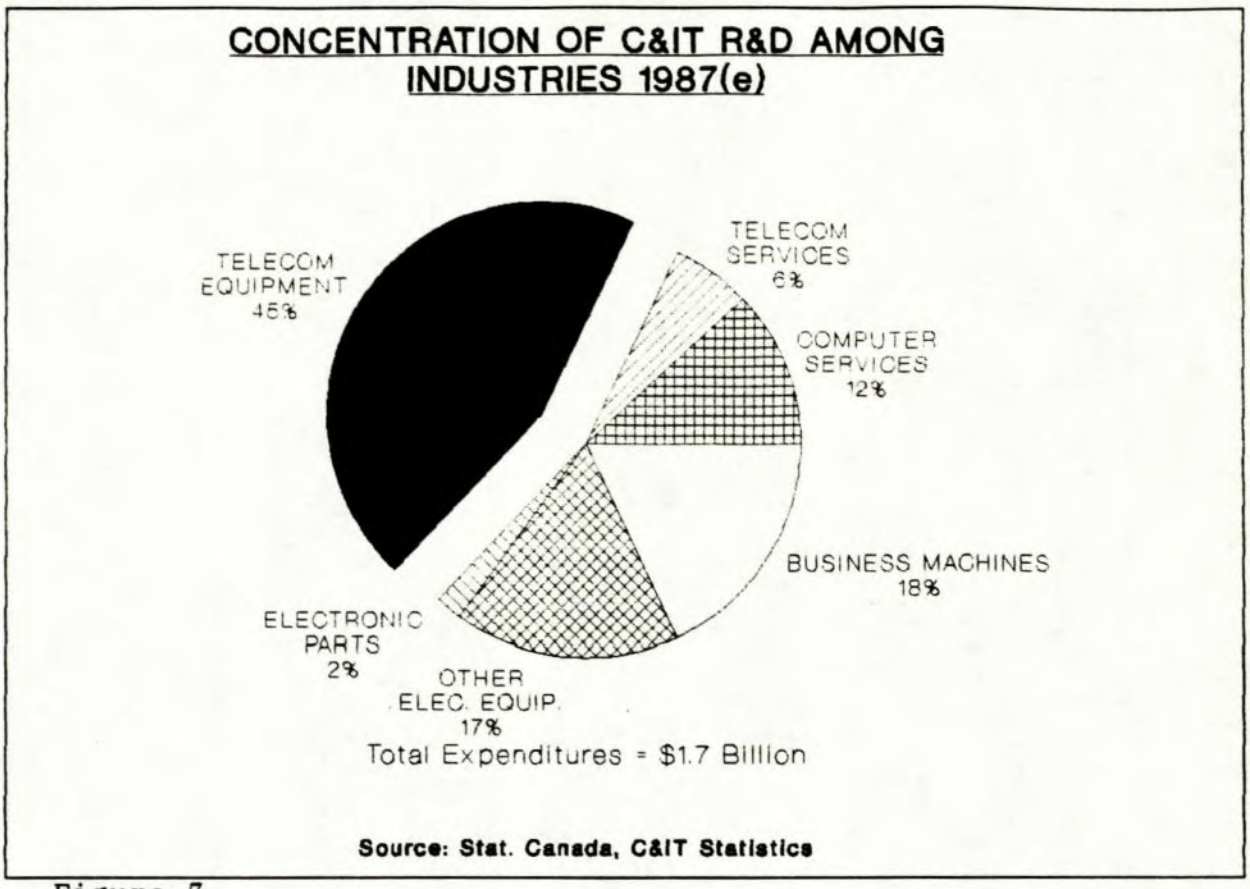

Figure 7

* Telecommunications equipment is the major performer within C&IT research and development, comprising almost one half of C&IT R&D expenditures.

* Business machines and computer services accounted for 30% of C&IT R&D expenditures.

* In terms of total industrial R&D in 1987, telecommunications equipment, business machines, and computer services accounted for 31% of expenditures.

Table VIII

AVERAGE TOTAL INTRAMURAL C&IT R&D EXPENDITURES, BY PERFORMING COMPANY SALES SIZE, 1986

Sales size	Number of firms	R&D expenditures	Average R&D expenditures
	no.	millions of dollars	
Less than $1,000,000	327	52	0.2
$1,000,000 to $10,000,000	201	131	0.6
$10,000,000 to $50,000,000	52	192	3.7
$50,000,000 to $100,000,000	5	18	3.6
Over $100,000,000	28	1,079	38.5
Total	613	1,472	2.4

Source: Stat. Canada, C&IT Statistics

Table IX

AVERAGE TOTAL INTRAMURAL C&IT R&D EXPENDITURES, BY EMPLOYMENT SIZE, 1986

Employment size	Number of firms	R&D expenditures	Average C&IT R&D expenditures	Average R&D expenditures all firms
	no.		(millions of dollars)	
1 - 49	469	123	0.3	0.2
50 - 99	50	49	1.0	0.5
100 - 199	30	69	2.3	0.7
200 - 499	27	88	3.2	1.1
500 - 999	13	94	7.2	2.5
1,000 - 1,999	5	9	1.9	1.9
2,000 - 4,999	14	316	22.6	8.5
>4,999	5	724	144.7	36.1
Total	**613**	**1,472**	**2.4**	**1.1**

Source: Stat. Canada, C&IT Statistics

Table X

CURRENT INTRAMURAL C&IT EXPENDITURES AS A PERCENT OF PERFORMING COMPANY SALES, BY INDUSTRY, AND BY COUNTRY OF CONTROL OF PERFORMER

C&IT industries	Canadian Owned	Foreign Owned	Total
	(percent of company sales)		
Manufacturing			
Telecommunication equipment	18	18	18
Electronic parts and components	8	5	7
Other electronic equipment	14	9	11
Electronic computing and peripherals, and electronic office, store and business machines	9	3	3
Services			
Telecommunication carriers and operators	1	1	1
Computer services	16	19	16
Computer equipment maintenance and repair	7	-	7
Total	6	4	6

Source: Stat. Canada, C&IT Statistics

Table XI

CURRENT INTRAMURAL C&IT R&D EXPENDITURES AS A PERCENTAGE OF PERFORMING COMPANY SALES, BY COUNTRY OF CONTROL OF PERFORMER, 1981 TO 1986

Country of control	1981	1982	1983	1984	1985	1986
			(percent)			
Canadian Owned	3.9	4.6	5.5	6.0	6.5	6.5
Foreign Owned	2.4	3.1	2.9	2.9	4.1	4.4
Total	3.3	4.0	4.4	4.7	5.5	5.7

Source: Stat. Canada, C&IT Statistics

Table XII

INTRAMURAL C&IT R&D EXPENDITURES, BY COUNTRY OF CONTROL AND BY INDUSTRY, 1986

Industry	Canadian Owned Performers R&D Expenditures	Foreign Owned Performers R&D Expenditures	Total Expenditures
	(millions of dollars)		
Telecom. equipment	522 (84%)	100 (16%)	622
Electronic parts and components	21 (69%)	9 (31%)	30
Other electronic equipment	137 (47%)	154 (53%)	291
Business Machines	68 (30%)	160 (70%)	228
Computer Services	194 (98%)	4 (2%)	198
Telecom. operators	94 (92%)	9 (8%)	103

NUMBER OF C&IT R&D PERFORMERS, BY COUNTRY OF CONTROL AND BY INDUSTRY, 1986

Industry	Number of Canadian Owned Performers	Number of Foreign Owned Performers	Total
Telecommunication equipment	16 (67%)	8 (33%)	24
Electronic parts and components	51 (85%)	9 (15%)	60
Other electronic equipment	89 (88%)	12 (12%)	101
Business Machines	70 (90%)	7 (10%)	78
Computer Services	344 (99%)	2 (1%)	346
Telecom. operators	* (91%)	* (9%)	*

* Estimated

Source: Stat. Canada, Industrial R&D Statistics 1986 (Cat. #88-202)

Graph

Table XIII

NUMBER OF PERSONS ENGAGED IN C&IT R&D BY OCCUPATIONAL CATEGORY AND BY DEGREE LEVEL, 1981 AND 1986

Occupation / Degree level	1981	1986
	(person-years, rounded to the nearest five)	
Professionals:		
Bachelor's	3,375	7,230
Master's	1,040	2,260
Doctorate	440	630
Sub-total	4,855	10,120
Supporting Staff		
Technicians and technologists	2,435	4,480
Others	1,505	2,650
Sub-total	3,940	7,130
Total	**8,795**	**17,250**
Total all industrial R&D personnel	32,420	47,245
C&IT personnel as percentage of total personnel	27%	37%

Source: Stat. Canada, C&IT Statistics

graph

Table XIV

NUMBER OF PERSONS ENGAGED IN C&IT R&D, BY PROVINCE AND BY OCCUPATIONAL CATEGORY, 1986

Region	Professionals	Other	Total
	(person-years, rounded to the nearest five)		
Atlantic provinces	65	90	155
Quebec	1,915	1,410	3,325
Ontario	6,985	5,000	11,985
Manitoba	15	20	35
Saskatchewan	110	65	175
Alberta	170	100	270
British Columbia	860	445	1,305
Total	**10,120**	**7,130**	**17,250**

Source: Stat. Canada, C&IT Statistics

Table XV

CURRENT C&IT R&D EXPENDITURES BY TYPE OF RESEARCH,

Type of research	R&D effort		Frequency
	Distribution	Current R&D budget	
	(percent)	(millions of dollars)	number
Basic research	12	111	23
Development of new products	63	591	62
Improvement of existing products	17	166	54
Development of new manufacturing processes	1	12	10
Improvement of existing manufacturing processes	1	7	10
Development of new technical services	3	31	18
Improvement of existing technical services	3	27	23
Total	100	945	105

Source: Stat. Canada, C&IT Statistics

Table XVI

C&IT R&D BY FIELD OF TECHNOLOGY, 1986

Technology	Relative importance	
	Primary	Secondary
	(number)	
Computer Hardware	83	35
Software and systems	123	17
Artificial intelligence	16	39
Transmission/carrier technologies	77	19
Other	27	4

Source: Stat. Canada, C&IT Statistics

Table XVII

PAYMENTS FOR C&IT TECHNOLOGICAL SERVICES, 1975 TO 1986

Year	Payments	Receipts	Balance
	(millions of dollars)		
1975	74	18	-56
1976	76	18	-58
1977	91	23	-68
1978	105	20	-85
1979	127	27	-100
1980	152	55	-97
1981	218	93	-125
1982	241	185	-56
1983	223	329	+106
1984	250	446	+196
1985	285	389	+104
1986	278	408	+130

Source: Stat. Canada, C&IT Statistics

Table XVIII

PAYMENTS FOR C&IT TECHNOLOGICAL SERVICES IN SELECTED INDUSTRIES, 1986

Industry	Payments	Receipts	Balance
	(millions of dollars)		
Business machines	184	116	-68
Telecommunications Equipment	77	233	156
Other sectors	17	59	42
Total	278	408	130

Source: Stat. Canada, Catalogue 88.202, 1986

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