

**The Economic Contribution of
Canada's R&D Intensive Enterprises
1994-2001**

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1. Introduction

The Canadian government, in launching its Innovation Strategy in 2002, set goals for growing the national economy, based on the belief that economic growth in the 21st century will be based on innovation. As an expression of this confidence, the Innovation Strategy set a national goal of advancing Canada from 15th to 5th position in the OECD GERD/GDP¹ ranking by 2010. In March 2003, Dr. H. Douglas Barber² showed that to get into the top five innovative economies by 2010, Canada would have to increase its investment in R&D from 1.9% of GDP in 2001 to over 3.1% of GDP in 2010.³ Assuming that other countries increase their own R&D investments consistent with recent history and that Canada's GDP will increase, Canada would have to increase its R&D investment from \$22 billion in 2001 to about \$50 billion by 2010.⁴

The federal government set a specific target for itself in its Innovation Strategy to double its own R&D spending by 2010. If the total public sector investment doubled from 2001 levels it would be about \$18 billion in 2010. The private sector contribution would have to make up the difference, increasing by about \$19 billion to about \$32 billion by 2010.

Since the country as a whole will need to spend over 3.1% of GDP on R&D by 2010, growing companies that are spending 3% or more of their revenue on R&D are essential to achieving the goal. It will not be enough to have all companies grow equally, since that would not change the GERD/GDP ratio. To reach our goal we need to see a larger proportion of growth in the firms spending 3% or more of revenue on R&D. We call such firms "R&D-intensive", because their investment in R&D is high and we expect them to be the major contributors to the growth of Canada's economy.

If we are looking to the "R&D-intensive" firms to help Canada achieve its target, we must understand that companies do not conduct R&D for its own sake. They invest in R&D to provide products and services to customers to achieve profitable sales. In order to support an increase of \$19 billion in R&D investments, the R&D-intensive private sector would need to generate new revenue of about \$175 billion and invest 11% of that in R&D. The revenue growth is what makes the economy grow. An increase of this size, largely in export revenue, would significantly increase trade and Canada's GDP. Our traded economy would increase by about \$160 billion or by 50% and our GDP would increase in the region of 10%. All Canadians would benefit through increased wealth, more jobs and increased resources for a higher quality of life.

The present study was specifically designed to provide a historical perspective from which to address the following key questions:

1. Is our national goal achievable?
2. Can we meet this goal by 2010?
3. Does Canada have sufficient R&D-intensive enterprise to reach this goal?
4. What can we do to ensure success?

¹ Gross Expenditure on R&D (GERD) as percent of Gross Domestic Product (GDP).

² H. Douglas Barber, "Can Canada's Private Sector Do Its Part to Move Canada Into The Five Most Innovative Economies of the World?" (Ottawa: ITAC/Research Infosource Inc., March 2003). Dr. Barber is co-founder and former CEO of Gennum Corporation.

³ His calculation took the historic growth of GERD/GDP of the top five innovative economies into account.

⁴ Based on projections made by Industry Canada, Innovation Policy Branch

We obtained data from Statistics Canada on industrial R&D for all the companies performing R&D in Canada going back to 1994. We sorted the firms into four groups by research intensity level (Exhibit 1) for the years 1994-2001⁵. For the purposes of the study, any firm spending less than 3% of revenue on R&D would not contribute significantly to the goal even if its revenues grow, since the R&D/revenue ratio would remain low. Firms spending 3% or more of revenue on R&D will help Canada approach the target as they grow, as long as they maintain their higher research intensities. We segmented these firms into three different groups, based on their stage of development. Start-up firms do not have significant revenues to cover both their R&D and operating costs. They are therefore financed by lenders or investors. Most are spending more than 100% of their revenue and so are drawing on the economy and not yet contributing to it. We picked a spending level of 50% of revenue on R&D as a threshold to define the Start-up group.

Firms spending between 3-50% of revenue on R&D are firms that have passed the start-up phase and are generating revenues to support their R&D investments. We divided these firms into two groups, based on their total spending on R&D. Early stage firms are small and not likely to contribute significantly to the economy or the R&D goal on the 2010 timeframe. We used a \$3 million expenditure on R&D as our threshold to separate the early stage firms from the R&D Leaders.

Exhibit 1. Research Intensity* Groups

1. **Low Research Intensity:** less than 3%
2. **R&D Leaders:** 3-50% and R&D spending of \$3 million or more
3. **Early Stage:** 3-50% and R&D spending of less than \$3 million
4. **Start-up:** greater than 50%

*R&D spending as percent of revenue

Based on these criteria, the intensity levels were defined in the following way:

1. Firms that spend less than 3% of revenue on R&D comprise the **Low Research Intensity** group.
2. Firms spending between 3-50% of revenue and \$3 million or more on R&D have higher revenues to support their higher R&D spending. These firms are at a later stage of development. This is called the **R&D Leaders** group.
3. That leaves a second group of R&D-intensive firms that spend 3-50% of revenue and less than \$3 million on R&D. These smaller firms are typically at an earlier stage of development. We labeled this the **Early Stage** group.
4. Finally, companies spending more than 50% of revenue on R&D are generally start-up ventures that are being financed by investors or lenders rather than customers. They have higher levels of risk and uncertainty and are more likely to contribute to Canada's performance in a longer timeframe than by 2010. This is the **Start-up** group.

⁵We were unable to obtain consistent data prior to 1994 because of methodology changes at Statistics Canada. As well, the 2001 numbers are only preliminary and have yet to be revised.

Exhibit 2 summarizes key data for 2001 for these four groups and historical growth measures from 1994-2001, based on our analysis of the Statistics Canada data. As we will demonstrate in the next section, the R&D Leaders group can and will be the driving force for meeting Canada's innovation goal.

**Exhibit 2. Summary of Key Data*, 2001⁺
by Research Intensity** Groups**

<u>Low Research Intensity</u> Research Intensity <3%	<u>R&D Leaders</u> Research Intensity 3-50% R&D spending of \$3 million or more	<u>Start-up</u> Research Intensity >50%					
<ul style="list-style-type: none"> ➤ <u>Number of companies:</u> 2,564 Declining 4.9%/yr ➤ <u>Revenue:</u> \$441.4B Growing 1.0%/yr ➤ <u>R&D spending:</u> \$1.9B Declining 0.4%/yr ➤ <u>Average research intensity*:</u> 0.4% ➤ <u>Employees:</u> 1,009,690 Declining 3.7%/yr 	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td data-bbox="573 478 1029 877"> <ul style="list-style-type: none"> ➤ <u>Number of companies:</u> 228 Growing 8.2%/yr ➤ <u>Revenue:</u> \$75.0B Growing 12.9%/yr ➤ <u>R&D spending:</u> \$7.8B Growing 13.2%/yr ➤ <u>Average research intensity*:</u> 11.7% ➤ <u>Employees:</u> 208,081 Growing 5.8%/yr </td> <td data-bbox="1029 478 1484 1381" rowspan="2"> <ul style="list-style-type: none"> ➤ <u>Number of companies:</u> 1,992 Growing 2.0%/yr ➤ <u>Revenue:</u> \$2.8B Growing 13.2%/yr ➤ <u>R&D spending:</u> \$2.3B Growing 8.0%/yr ➤ <u>Average research intensity*:</u> 104.2% ➤ <u>Employees:</u> 58,782 Growing 13.9%/yr </td> </tr> <tr> <td data-bbox="573 877 1029 1381"> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th data-bbox="573 877 1029 997"> <u>Early Stage</u> Research Intensity 3-50% R&D spending less than \$3 million </th> </tr> <tr> <td data-bbox="573 997 1029 1381"> <ul style="list-style-type: none"> ➤ <u>Companies:</u> 4,109 Declining 2.3%/yr ➤ <u>Revenue:</u> \$11.2B Growing 0.5%/yr ➤ <u>R&D spending:</u> \$1.2B Growing 2.1%/yr ➤ <u>Average research intensity*:</u> 9.6% ➤ <u>Employees:</u> 99,912 Growing 0.2%/yr </td> </tr> </table> </td> </tr> </table>	<ul style="list-style-type: none"> ➤ <u>Number of companies:</u> 228 Growing 8.2%/yr ➤ <u>Revenue:</u> \$75.0B Growing 12.9%/yr ➤ <u>R&D spending:</u> \$7.8B Growing 13.2%/yr ➤ <u>Average research intensity*:</u> 11.7% ➤ <u>Employees:</u> 208,081 Growing 5.8%/yr 	<ul style="list-style-type: none"> ➤ <u>Number of companies:</u> 1,992 Growing 2.0%/yr ➤ <u>Revenue:</u> \$2.8B Growing 13.2%/yr ➤ <u>R&D spending:</u> \$2.3B Growing 8.0%/yr ➤ <u>Average research intensity*:</u> 104.2% ➤ <u>Employees:</u> 58,782 Growing 13.9%/yr 	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th data-bbox="573 877 1029 997"> <u>Early Stage</u> Research Intensity 3-50% R&D spending less than \$3 million </th> </tr> <tr> <td data-bbox="573 997 1029 1381"> <ul style="list-style-type: none"> ➤ <u>Companies:</u> 4,109 Declining 2.3%/yr ➤ <u>Revenue:</u> \$11.2B Growing 0.5%/yr ➤ <u>R&D spending:</u> \$1.2B Growing 2.1%/yr ➤ <u>Average research intensity*:</u> 9.6% ➤ <u>Employees:</u> 99,912 Growing 0.2%/yr </td> </tr> </table>	<u>Early Stage</u> Research Intensity 3-50% R&D spending less than \$3 million	<ul style="list-style-type: none"> ➤ <u>Companies:</u> 4,109 Declining 2.3%/yr ➤ <u>Revenue:</u> \$11.2B Growing 0.5%/yr ➤ <u>R&D spending:</u> \$1.2B Growing 2.1%/yr ➤ <u>Average research intensity*:</u> 9.6% ➤ <u>Employees:</u> 99,912 Growing 0.2%/yr 	
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<u>Total Companies</u>							
<ul style="list-style-type: none"> ➤ <u>Companies:</u> 8,893 Declining 2.7%/yr ➤ <u>Revenue:</u> \$530.4B Growing 2.1%/yr ➤ <u>R&D spending:</u> \$13.2B Growing 8.2%/yr ➤ <u>Average research intensity*:</u> 1.9% ➤ <u>Employees:</u> 1,376,465 Declining 2.5%/yr 							
<p>*Average research intensity and yearly growth rates based on 1994-2001 numbers **R&D spending as percent of revenue</p>		<p>+Preliminary numbers Note: may not add due to rounding</p>					

2. Retrospective Review of Firms by Research Intensity, 1994-2001

This section will review the Statistics Canada data for the period 1994-2001. We will analyze the data by each intensity level group as outlined in Exhibit 1 and 2 above, with particular emphasis on six key variables: number of companies, revenue, R&D spending, research intensity (R&D spending as percent of revenue), number of employees and number of R&D employees⁶.

2.1 Low Research Intensity Group: Research Intensity Less than 3%

This group contains many of Canada's large, well-established firms that drove the economy in the past century. They remain very important as they still account for a major part of the Canadian economy. However, the data indicates that their economic impact is slowly declining.

- The Low Research Intensity group recorded a significant decline in the number of firms from 1994-2001. There were 2,564 companies in 2001, down from 4,287 in 1994 (a decline of 40.2% or 4.9% per year).
- Although this group accounted for the largest share of total revenue over the period, generating 83% of total revenue for all groups in 2001 (\$441.4B), this contribution was down from 90% in 1994. From 1994-2001, this group saw a revenue increase of 6.8% or 1.0% per year. Taking inflation into account, total revenue declined over the period.
- R&D spending for these companies also declined over this period (-2.5% or -0.4% per year). The group's contribution to total R&D spending for all groups declined from 25% in 1994 to 14% in 2001.
- The group as a whole spent an average of 0.4% of revenue on R&D from 1994-2001.
- The total number of employees for this group declined by 418,140 (-29.3%) over the period.
- The number of R&D employees declined almost as much (-24.1%) from 1994-2001. Overall, the Low Research Intensity companies accounted for 15% of total R&D employees among the four groups in 2001, down from 26% in 1994.

**Table 1. Low Research Intensity Group, 1994, 2001
(Research Intensity* Less than 3%)
Summary**

Performance Measure	1994	2001**	% Change 1994-2001	% per Year
Number of Companies	4,287	2,564	-40.2	-4.9
Revenue (\$M)	\$413,232.3	\$441,408.6	6.8	1.0
% of Total Revenue for all Groups	90	83	-7.9	
R&D Spending (\$M)	\$1,905.2	\$1,856.7	-2.5	-0.4
% of Total R&D Spending for all Groups	25	14	-44.0	
R&D Intensity* (%)	0.5	0.4	-8.8	
Number of Employees	1,427,830	1,009,690	-29.3	-3.7
% of Total Employees for all Groups	84	73	-13.1	
Number of R&D Employees (FTE)	20,304	15,403	-24.1	-3.1
% of Total R&D Employees for all Groups	26	15	-40.5	

*R&D spending as percent of revenue

**Preliminary numbers

Note: may not add due to rounding

⁶ Detailed tables can be found in the Appendices.

2.2. Early Stage Group: Research Intensity 3-50% and R&D Spending Less than \$3 Million

The Early Stage group contains small firms at relatively early stages of development.

- This group comprised the largest of the four groups. In 2001, it contained 4,109 companies, a decline from 4,981 in 1994 (-17.5% or -2.3% per year).
- The Early Stage group's total revenue of \$11.2 billion represented only 2% of total revenue for all groups in 2001. Revenue growth over the period was virtually flat (3.2% or 0.5% per year).
- This group invested \$1.2 billion in R&D in 2001 or 9% of the total R&D spending for all groups. This was down from 14% of total R&D spending for all groups in 1994. Early Stage firms increased their total R&D spending by 16.0% from 1994-2001 (2.1% per year).
- From 1994-2001, Early Stage firms reported an average research intensity of 9.6%.
- The number of employees was 99,912 in 2001 and remained relatively constant, growing only 1.2% over the period.
- On average, the Early Stage group employed just over 20% of the total number of R&D employees for all groups from 1994-2001. The number of R&D employees in this group grew 22.7% from 1994-2001 or 3.0% per year, from 18,058 in 1994 to 22,156 in 2001.

Given the healthy average research intensity of 9.6% and the relatively stable revenue and employment of this group over the 1994-2001 period, one would have expected a significant number of the roughly 4,400 Early Stage companies to have moved into the R&D Leaders group. However, as will be seen in Section 2.4, the number of R&D Leaders companies only grew by an average of 14 companies per year from 1994-2001. Over the period, on average a Early Stage firm generated \$2.5 million in revenue, employed 23 people and had the equivalent of 4 people in R&D. Over eight years there has been no significant change. These firms seem to be going nowhere. Indeed, constant revenue per employee indicates some real decline. Why do so few of these Early Stage firms experience significant revenue growth? What is happening to these companies? Are there policy implications at play? We will return to these issues in the final section of this report.

Table 2. Early Stage Group, 1994, 2001
(Research Intensity* 3-50% and R&D Spending Less than \$3 Million)
Summary

Performance Measure	1994	2001**	% Change 1994-2001	% per Year
Number of Companies	4,981	4,109	-17.5	-2.3
Revenue (\$M)	\$10,883.3	\$11,228.2	3.2	0.5
% of Total Revenue for all Groups	2	2	-11.1	
R&D Spending (\$M)	\$1,024.2	\$1,188.0	16.0	2.1
% of Total R&D Spending for all Groups	14	9	-33.4	
R&D Intensity* (%)	9.4	10.6	12.4	
Number of Employees	98,693	99,912	1.2	0.2
% of Total Employees for all Groups	6	7	24.3	
Number of R&D Employees (FTE)	18,058	22,156	22.7	3.0
% of Total R&D Employees for all Groups	23	22	-3.8	

*R&D spending as percent of revenue **Preliminary numbers

Note: may not add due to rounding

2.3 Start-up Group: Research Intensity Greater than 50%

The Start-up group contains mainly ventures that are being financed because sales are lower than costs.

- This group showed the most volatility over the period. The number of firms grew rapidly through the high-tech boom increasing from 1,733 companies in 1994 to 3,373 in 2000 (94.6%). It is still unclear yet whether they have flattened out or declined after this peak.⁷ Furthermore, the number of companies in this group may have increased post 2001 as a result of cutbacks that have occurred in the R&D Leaders group, which was hard hit in the crash of 2001⁸.
- On average, Start-up firms had less than 1% of total revenue for all groups (0.3%) from 1994-2001.
- Revenue growth was volatile over the period, climbing slowly for four years, dropping 26.1% in 1998, jumping 17.5% in 1999, more than doubling in 2000 (143.1%) and climbing 8.1% in 2001. Over the period, this represented a revenue increase of 138.0% - the highest revenue growth of all the groups.
- The Start-up group's R&D spending from 1994-2001 accounted for on average 17% of total R&D spending for all groups.
- The group spent on average more than 100% of total revenue on R&D from 1994-2001. That is clear evidence that these companies are typically in early stages of development being financed with expectations of future return. They are making significant investments in R&D, but because their sales are less than their costs, they are still drawing on the economy rather than contributing to it.
- These Start-up firms reported significant growth in the number of employees from 1994-2001 increasing by 148.0% from 23,701 employees in 1994 to 58,782 employees in 2001.
- The number of R&D employees also increased during this period by 42.4% to 20,864 in 2001.

We would have hoped that more of the Start-up companies would have moved into the Early Stage and R&D Leaders groups during the time period. However, these start-up companies represent higher risk, lower probability of success and longer time to get there. This raises questions about what would lower the risks, increase the probability of success and reduce the timeline.

**Table 3. Start-up Group, 1994, 2001
(Research Intensity* Greater than 50%)
Summary**

Performance Measure	1994	2001**	% Change 1994-2001	% per Year
Number of Companies	1,733	1,992	14.9	2.0
Revenue (\$M)	\$1,196.5	\$2,847.2	138.0	13.2
% of Total Revenue for all Groups	0.3	0.5	105.1	
R&D Spending (\$M)	\$1,366.5	\$2,344.9	71.6	8.0
% of Total R&D Spending for all Groups	18	18	-1.5	
R&D Intensity* (%)	114.2	82.4	-27.9	
Number of Employees	23,701	58,782	148.0	13.9
% of Total Employees for all Groups	1	4	204.6	
Number of R&D Employees (FTE)	14,651	20,864	42.4	5.2
% of Total R&D Employees for all Groups	19	21	11.6	

*R&D spending as percent of revenue

**Preliminary numbers

Note: may not add due to rounding

⁷ Once Statistics Canada has revised the 2001 numbers, the trend will become clearer.

⁸ Employees laid off from firms in the R&D Leaders group in 2000 and 2001 may have started their own companies by 2002 and 2003.

2.4 R&D Leaders Group: Research Intensity 3-50% and R&D Spending of \$3 Million or More

The companies in this group are more established with a significant revenue base and good growth potential.

- This group contained the least number of companies of the four groups - on average, only 2% of the total number of companies in all four groups. However, the number of firms in this group grew steadily at 8.2% per year from 1994-2001. This growth rate surpassed the other groups, although it only represented on average 14 new firms added each year. The fact that the number of companies in the R&D Leaders group has been growing while the Low Research Intensity group with the largest revenue stream has not, underlines the importance of this group for Canada's knowledge-based economy.
- R&D Leaders firms' contribution to total revenue for all groups doubled from 7% in 1994 to 14% in 2001. Actual revenue more than doubled in this period increasing from \$32.0 billion in 1994 to \$75.0 billion in 2001 translating into a growth of 134.3% or 12.9% per year.
- The R&D Leaders group more than doubled its R&D spending over the period – from \$3.3 billion in 1994 to \$7.8 billion in 2001 – a growth of 138.1% or 13.2% per year. The group had the strongest R&D performance of all the groups (Exhibit 3). Since 1997, the R&D Leaders companies spent more on R&D than the other groups combined. In 2001, these R&D Leaders companies were responsible for 59% of all R&D spending for the four groups, up from 43% in 1994.
- On average, companies in the R&D Leaders group spent 11.7% of revenue on R&D from 1994-2001. The highest research intensity level achieved by this group was 13.5% in 1998.

Table 4. R&D Leaders Group, 1994, 2001
(Research Intensity* 3-50% and R&D Spending of \$3 Million or More)
Summary

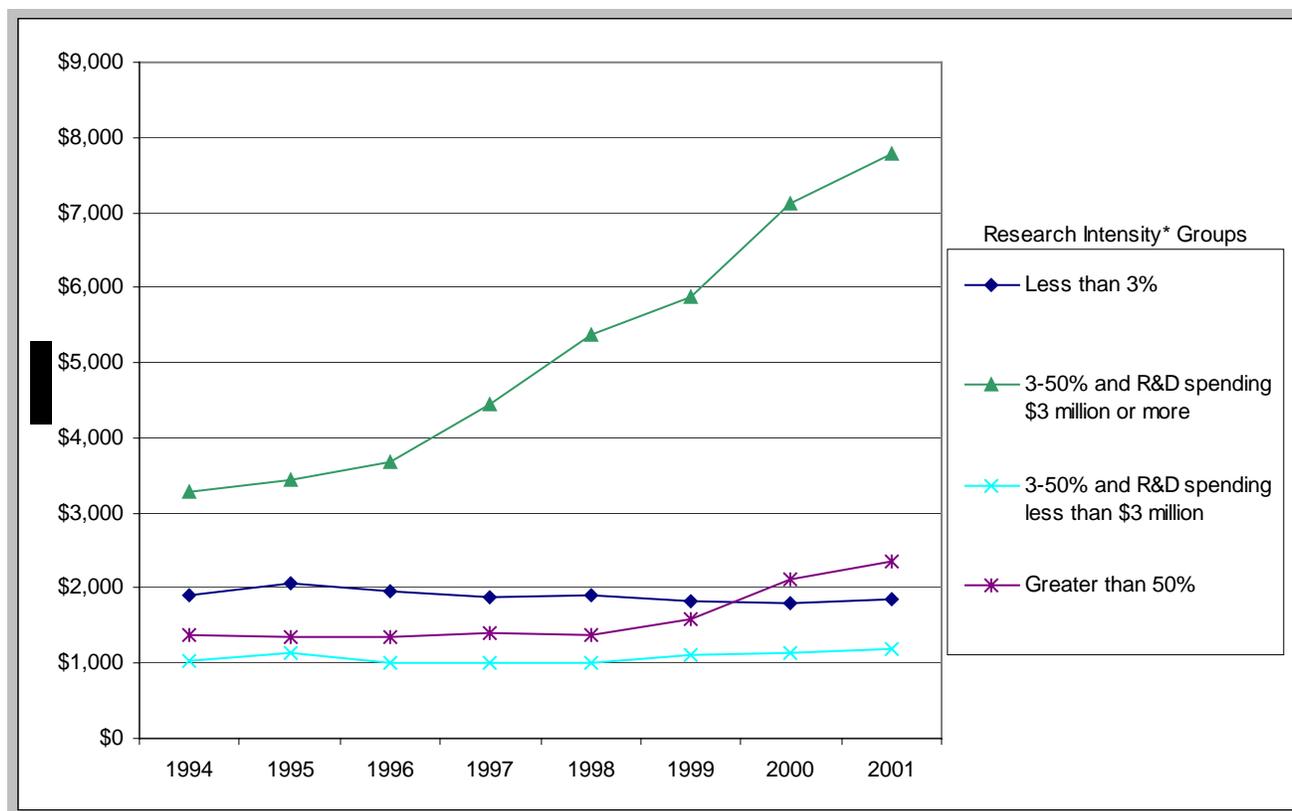
Performance Measure	1994	2001**	% Change 1994-2001	% per Year
Number of Companies	131	228	74.0	8.2
Revenue (\$M)	\$31,986.6	\$74,958.9	134.3	12.9
% of Total Revenue for all Groups	7	14	102.0	
R&D Spending (\$M)	\$3,271.3	\$7,789.5	138.1	13.2
% of Total R&D Spending for all Groups	43	59	36.7	
R&D Intensity* (%)	10.2	10.4	1.6	
Number of Employees	140,371	208,081	48.2	5.8
% of Total Employees for all Groups	8	15	82.1	
Number of R&D Employees (FTE)	25,870	42,235	63.3	7.3
% of Total R&D Employees for all Groups	33	42	27.9	

*R&D spending as percent of revenue

**Preliminary numbers

Note: may not add due to rounding

Exhibit 3. R&D Spending by Research Intensity* Groups, 1994-2001



*R&D spending as percent of revenue

- While revenue was growing, the number of employees also grew from 140,371 employees in 1994 to 208,081 employees in 2001 (48.2% or 5.8% per year). Revenue per employee grew 58.1% over the period or 6.8% per year. These figures indicate both a growth in value creation and in productivity.
- Likewise, as would be expected, these companies also experienced positive growth in number of R&D employees (63.3% or 7.3% per year) and R&D spending per employee increased 45.9% or 5.5% per year over the period 1994-2001.

Some R&D Leaders firms saw revenue growth of 20% per year or higher during this period. Because of this, many analysts and policy makers have come to expect growth rates significantly higher than this for R&D Leaders firms. From the historical data, we see that the R&D Leaders companies, our highest performing group of companies in Canada, have experienced, on average, a revenue growth of less than 13.0% per year from 1994-2001. This is a sobering reality.

However, that being said, the R&D Leaders group is the only group of companies that demonstrated strong growth in every performance measure over the period 1994-2001. It is already making a significant contribution to the economy. In Section 3, we will use the historical performance measures for this group of firms to estimate whether there is the capacity in the private sector to move Canada into the top five innovative economies of the world by 2010.

2.5 The Role of the ICT Sector

Canada's Information and Communications Technology (ICT) sector has been credited with fuelling a significant proportion of Canada's economic growth over the past decade. In this section we use the Statistics Canada data to summarize the ICT sector's role in the R&D Leaders group as well as the other groups⁹.

2.5.1. ICT Sector Role in the R&D Leaders Group: Research Intensity 3-50% and R&D Spending of \$3 Million or More

- In 2001, ICT firms made up just over half (52%) of the firms in the total R&D Leaders group - increasing from 40% of the total in 1994.
- On average, ICT firms accounted for 48% of revenue in the total R&D Leaders group from 1994-2001. Revenue growth for ICT firms in the R&D Leaders group over this period was 130.5% or an average of 12.7% per year, essentially driving the revenue growth of the total R&D Leaders group from 1994-2001 (134.3% or 12.9% per year).

**Table 5. R&D Leaders Group, 1994-2001
(Research Intensity* 3-50% and R&D Spending of \$3 Million or More)
ICT Sector vs. All Companies
Summary**

Performance Measure	R&D Leaders Group: Research Intensity 3-50% and R&D Spending of \$3 Million or More							
	ICT Sector				All Companies			
	1994	2001**	% Change 1994-2001	% per Year	1994	2001**	% Change 1994-2001	% per Year
Number of Companies	53	119	124.5	12.3	131	228	74.0	8.2
Revenue (\$M)	\$17,067.8	\$39,345.7	130.5	12.7	\$31,986.6	\$74,958.9	134.3	12.9
% of Total R&D Leaders Group Revenue	53	52	-1.6	0.5				
R&D Spending (\$M)	\$2,003.7	\$4,917.1	145.4	13.7	\$3,271.3	\$7,789.5	138.1	13.2
% of Total R&D Leaders Group R&D Spending	61	63	3.1	0.4				
R&D Intensity* (%)	11.7	12.5	6.5	0.9	10.2	10.4	1.6	
Number of Employees	71,117	101,237	42.4	5.2	140,371	208,081	48.2	5.8
% of Total R&D Leaders Group Employees	51	49	-4.0	-0.6				
Number of R&D Employees (FTE)	16,846	27,021	60.4	7.0	25,870	42,235	63.3	7.3
% of Total R&D Leaders Group R&D Employees	65	64	-1.8	-0.3				

*R&D spending as percent of revenue **Preliminary numbers

Note: may not add due to rounding

- ICT firms accounted for the majority of the R&D spending in the R&D Leaders group throughout the period. In 2001, ICT firms spent a total of \$4.9 billion on R&D, accounting for 63% of all R&D spending in the total R&D Leaders group.

⁹ We also obtained data for Pharmaceutical/Medicine Manufacturing and Aerospace. However, the Pharmaceutical data only included companies that Statistics Canada has traditionally attributed to the Pharmaceutical/Medicine sector – which is incomplete. They are currently working on updating this industry sector classification to more accurately reflect the true nature of the sector to include companies from manufacturing, services, wholesalers and biotechnology. For the Aerospace sector, the base size of companies was small, so we are not presenting a summary for this sector. Detailed tables for these two sectors can be found in Appendix B.

- The average research intensity for the ICT sector companies surpassed the average intensity for the total R&D Leaders group (14.5% vs. 11.7%) from 1994-2001.
- From 1994-2001, on average, just under half of the employees and almost two thirds of the R&D employees were from the ICT sector.

These performance measures clearly indicate the dominant role that ICT firms played in the R&D Leaders group.

2.5.2. ICT Sector Role in the Other Groups

Low Research Intensity Group: Research Intensity Less than 3%

- On average, ICT firms made up less than 10% of the total Low Research Intensity group. However, with information technology being so ubiquitous, these methods of defining sectors underestimate the role of highly knowledgeable information technology people in the innovations arising throughout the groups.

Early Stage Group: Research Intensity 3-50% and R&D Spending Less than \$3 Million

- On average from 1994-2001, one-third of the companies in the total Early Stage group were from the ICT sector.
- ICT firms generated one-third of the revenue in the total Early Stage group in 1994, rising to 38% in 2001.
- Revenue growth of ICT firms outperformed the group total from 1994-2001 (ICT revenue growth of 20.6% vs. 3.2% for the total Early Stage group).
- ICT firms accounted for 40% of total R&D spending for the group in 1994, rising to 46% in 2001.
- The average research intensity from 1994-2001 was higher for ICT firms (11.7%) than for the total Early Stage group total (9.6%).
- On average over the period, ICT firms employed just over one-third of employees (35%) in the total Early Stage group and just under half of the number of R&D employees (46%).

Start-up Group: Research Intensity Greater than 50%

- The role of ICT firms in the Start-up group was significant before the tech bubble burst. Almost half the revenue in the total Start-up group came from the ICT sector in 1994, but the ICT group's contribution declined to 16% by 2001, clearly a reflection of the dot.com decline.
- ICT firms' revenue declined in this group (-18.5%) from 1994-2001 compared to a 138.0% increase for the total Start-up group, again reflecting the dot.com decline. As we noted earlier, it is uncertain whether that decline will continue or the ICT companies in this group will turn themselves around and move into a new growth phase in the future.

3. Assessing the Innovation Goal for Canada

This section will discuss and answer our key questions:

1. Is our national goal achievable?
2. Can we meet this goal by 2010?
3. Does Canada have sufficient R&D-intensive enterprise to reach this goal?
4. What can we do to ensure success?

3.1 Is our national goal achievable?

In order to achieve our goal, private sector R&D spending will have to grow from about \$13 billion in 2001 to about \$32 billion in 2010, for an increase of roughly \$20 billion. This growth in R&D spending will not occur without the revenue growth to support it at a business-sensible research intensity (R&D spending as percent of revenue). We will project future revenue growth using the average annual compounded revenue growth demonstrated by the R&D Leaders group from 1994-2001. Based on this revenue growth and assuming research intensity from historical performance, we will assess whether the goal is achievable relying solely on the R&D Leaders group of firms.

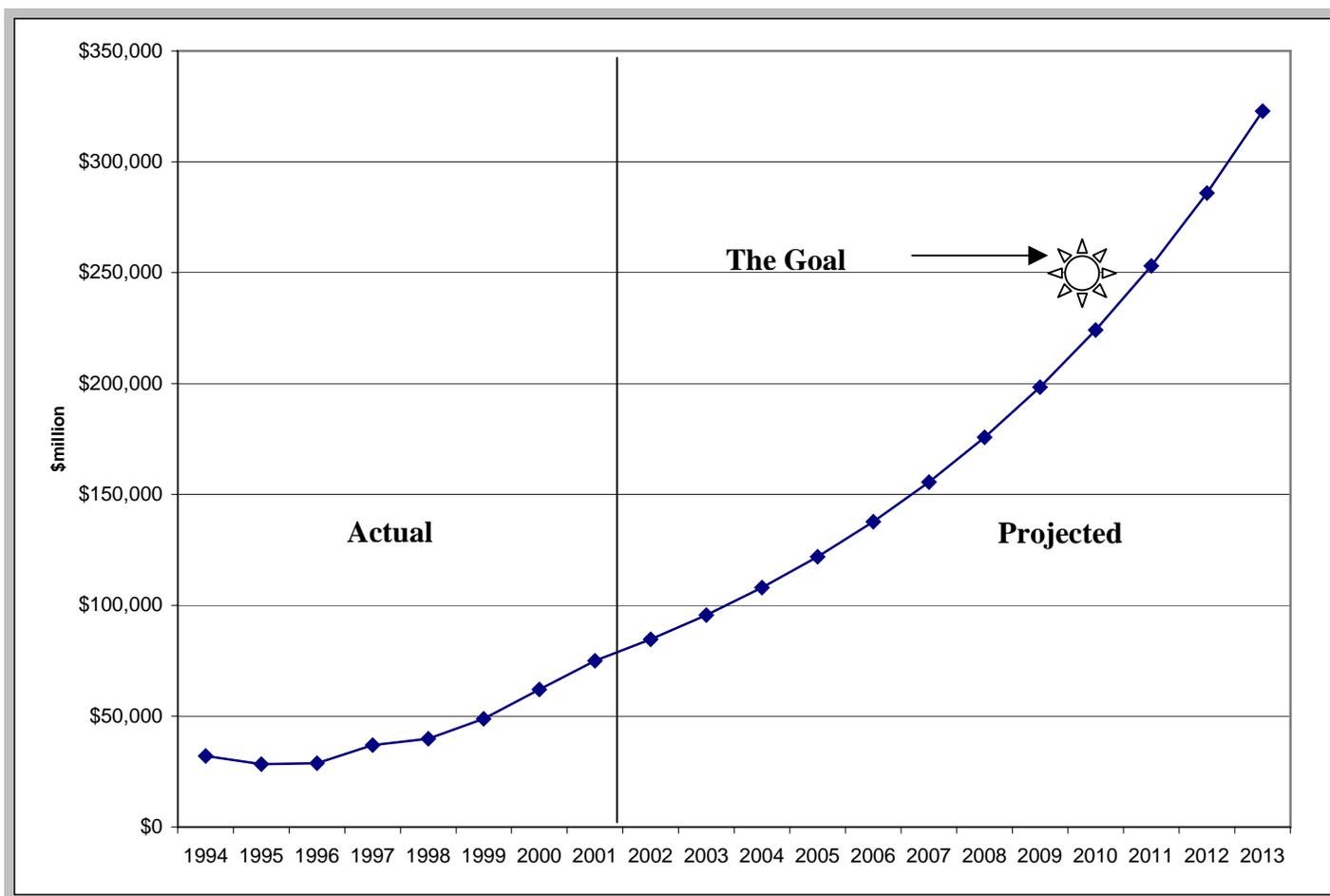
Total revenue for the R&D Leaders group grew historically at 12.9% per year. Research intensity averaged 11.7% historically. We will use a more conservative figure of 11% to calculate future R&D spending based on the revenue projections into the future.

Using the R&D Leaders group as our base, we start with 228 companies in 2001 having total revenue of \$75 billion, growing at 12.9% per year. Exhibit 4 projects revenue going forward at this rate. By 2011, these firms will have increased in number to 503 and generate \$253 billion in revenue, or \$178 billion in new revenue over 2001 levels¹⁰. By investing 11% of these new revenue on R&D, this group of firms will spend an additional \$19.6 billion in 2011. This performance is in the range required to meet the goal.

Given that the R&D Leaders group of firms could achieve the goal by 2011, and that the other groups of firms will experience some growth, we can conclude that the answer to the first question is “yes”. Our national goal is achievable by 2010 or 2011.

¹⁰If we use historic growth rates for the R&D Leaders firms (12.9% per year) and for the Low Research Intensity group (1% per year), it is interesting to note that by 2017 the revenue or contribution to the economy of the R&D Leaders firms will have surpassed the Low Research Intensity group (\$523 billion and \$517 billion respectively).

Exhibit 4. Actual and Projected Revenue*, 1994-2013
R&D Leaders Group: Research Intensity 3-50% and R&D Spending \$3 million or more



*Assumes a 12.9% average annual compounded growth rate between 2001-2013

3.2 Can we meet this goal by 2010?

In the previous section we made a preliminary attempt at answering this question, based solely on the R&D Leaders group of firms. But there are additional considerations.

The only group other than the R&D Leaders group with significant historical revenue growth is the Start-up group. Although growth was volatile from 1994-2001, over the period the growth was equivalent to an average compound growth of 13.2% per year. If we assume that this group continues to grow on average at 13.2% per year, then by 2010 an additional \$6 billion in private sector revenue would be available in that year. Even if we use a conservative research intensity of 70%¹¹, this would add another \$4 billion in R&D spending in 2010. The R&D Leaders group would generate \$224 billion in revenue by 2010, or an increase of \$149 billion. Spending 11% on R&D would yield \$16.4 billion, plus the \$4 billion from the Start-ups, yielding a total of \$20.4 billion in new R&D spending. This total, which does not include any growth from the other two groups, is in the range required to meet the goal by 2010. However, the economic situation is uncertain.¹²

- ◆ *The R&D Leaders group and the Start-up group together could generate \$233 billion in revenue supporting about \$31 billion in R&D expenditure by the year 2010.*
- ◆ *The other two groups could add about \$2 billion more in R&D for a total of \$33 billion on total revenue of \$727 billion by 2010.*
- ◆ *Based on these projections, we can say that by 2010, Canada could reach its innovation goal of moving in the top five R&D-intensive economies of the world.*
- ◆ *However, this leaves very little cushion for economic downturns or other circumstances that may slow revenue growth.*

¹¹ The Start-up group of companies typically spent on average 100% or more of revenue on R&D from 1994-2001.

¹² Research Infosource Inc. data for 2002 indicates that over 600 R&D-intensive firms increased revenue by 2.0% and the group's R&D investments were down by 8.6%. Statistics Canada's preliminary estimates predict that R&D investment will be down for their 2002 data. The picture is not clear for our competitor countries, so it is difficult to know whether our relative performance is on track. As more data becomes available, a clearer picture of the trends will emerge.

3.3 Does Canada have sufficient R&D-intensive enterprise to reach this goal?

Section 3.1 showed that based on historical performance in revenue growth and R&D spending the R&D Leaders group of firms alone can get us to the goal by 2011. However, this projection depends on the fortunes of a few hundred firms. Are we guaranteed that they will perform as they did historically? Can we be sure that if they do, they will stay in Canada?

In another study, Dr. Barber and Dr. Jeffrey Crelinsten, President of Research Infosource Inc., interviewed 31 CEOs and senior executives of R&D-intensive firms to ask them what issues they feel are most important for their businesses.¹³ Some of these leaders warned of two detrimental trends already evident. First, with subsidiary operations in other parts of the world some of these companies gradually relocate outside Canada. Second, as companies grow to a medium-size, the founders look to liquidate some of their assets or look for alternatives to make the next step. For Canada, with less than 3% of the global economy, the internal market is limited and the potential for foreign purchase is high.

If we take the Start-up group of about 2,000 firms and the Early Stage group of about 4,000 firms, we have a total of about 6,000 companies that have the potential of moving into the R&D Leaders group. The historical data indicated, however, that the number of companies in the R&D Leaders group has only been growing at about 8.2% per year, adding on average 14 firms to its population every year. This represents a low yield from 6,000 plus potential candidates. Is this also an opportunity? What would be required to double that rate?

If measures could be put into place that would increase the number of firms entering this important R&D Leaders group and staying in Canada, then reaching our goal would be more secure.

The data suggests that we have just the right base of enterprise to reach our goal – with no margin for error.

¹³Can the Private Sector Get Canada into the Top Five Innovative Economies of the World by 2010?: Views from Leaders of Canada's Innovation-Intensive Firms (Ottawa: ITAC/Research Infosource Inc., September 2003).

3.4 What can we do to ensure success?

From the preceding analysis it is clear that the fortunes of the R&D Leaders group will be critical to our success. As the main engines of revenue growth and the major investors in R&D in Canada, these firms must experience Canada as a favorable environment for their businesses. Canadians are respected players in the global economy and as such their companies are able to locate anywhere in the world. Canada must create an environment that values and encourages these firms to remain in Canada and to grow here.

Again, based on the interviews with business leaders conducted by Barber and Crelinsten mentioned in the previous section, the overriding message from these leaders was the need for a culture that understands and embraces commerce. They feel that Canadians generally mistrust business. This attitude pervades institutions that have significant impact on R&D-intensive firms, including universities and governments. It is an attitude that reinforces a poor understanding of the relationship between research and commerce in a knowledge-based business.

As global players, these enterprises work with the knowledge of the world. Canada's contribution to that is small. By contrast, these firms depend almost completely on Canada's educational system for knowledgeable people. Graduates from Canadian universities and colleges are skilled people who normally want to find work near family and community. Unfortunately, the pool of appropriately skilled graduates coming out of Canadian higher education institutions is too small to fill the need. The skill set of the graduates is too narrow. The commerce-averse culture inhibits them from learning management, teamwork, marketing, customer relations and other commerce-related skills so necessary to excel in an R&D-intensive firm that competes globally.

The prevailing business model in Canada for an R&D-intensive business is that the starting point is an idea, which is then "commercialized". According to this model, a successful business strategy is to find ideas from researchers and develop these ideas into products and services. The researchers can be located at educational institutions, research organizations, in the company itself or even in other companies. This model works poorly, because it is not customer-centred. The traditionally low yield of commercial activity from university IP is one example. The business model used by growing, profitable R&D-intensive firms is much more successful. It is rooted in understanding needs and opportunities. The R&D Leaders firms have developed ways to talk to customers, ways to identify needs, ways to spot value-creation opportunities and ways to develop knowledge-based solutions that the customers find valuable at attractive prices. These firms need technically-trained people who can and want to communicate with customers and who can lead teams to meet their customer's needs better than the competition on every level.

Herein lies a possible answer to the question posed earlier about the poor growth performance of the large number of Early Stage firms. Some of the business leaders we talked to noted that managers of small Canadian technology firms often have a poor understanding of how to run their business. They tend to focus on the technology and its development rather than the customers and their needs. Many of these firms are run by engineers and scientists who have created a company around a promising technology. They may have spun the company out of a university department. Yet they lack the commerce skills necessary to run their business.

Several of the business leaders we talked to mentioned that the same problem exists in their own companies. New hires from Canadian universities have to grow into the commerce culture. Because of the aversion to business this is not an automatic development. There is a tendency for Canadian-trained

people with good technical skills to be less customer-focused and more captivated by the technical challenges of a development.

It is commonly believed that there is a dearth of existing firms in Canada that can license technology from universities or interact with small technology firms and help them grow through business exchange, joint ventures or acquisitions¹⁴. Our discussions with leaders of R&D-intensive firms suggest that the reasons may lie elsewhere, having more to do with the lack of commerce-related values among Canada's technology entrepreneurs and managers within industry and within academia and government.

Another reason often given for the failure of start-up and early stage companies to progress is too little venture financing. Our discussions have led us to believe that the greater problem is the small number of early stage opportunities that have good management and marketing and a sound business proposition for investment.

Leaders noted that the commerce-averse culture in Canada also affects government policies and practices that impact on the overall business environment in which R&D-intensive firms operate. Regulatory bodies whose employees do not see their work in a global context create obstacles for domestic firms rather than establishing best practices in regulation that are internationally competitive and that contribute to the competitive capability of Canadian business. They view themselves as watchdogs of business rather than internationally competitive regulators competing with those of other countries. Individuals who are trained in a commerce-averse culture develop tax policies and are often suspicious of entrepreneurs trying to build businesses and grow companies. Societal commerce-aversion creates a drag for global businesses.

In summary, the key issues facing R&D Leaders firms in Canada today are the need for commerce-competent, highly skilled graduates from Canadian institutions of higher learning, and a competitive environment in Canada for doing business in the knowledge economy. If these issues could be addressed properly, then all firms would benefit, no matter which of the four groups the companies fall into today. It is also possible that there would be an increasing flow of firms into the R&D Leaders group and an increasing number staying and growing in Canada.

¹⁴ Commonly referred to as Canada's low receptor capacity.

Appendix A: Detailed Tables by Research Intensity Level All Companies, 1994-2001

Table A1. Number of Companies

Table A2. Revenue

Table A3. R&D Spending

Table A4. Research Intensity

Table A5. Total Employees

Table A6. R&D Employees

Table A1. Number of Companies by Research Intensity Level, 1994-2001
All Companies

Research Intensity* Level	Number of Companies (#)								% Change 1994-2001
	Fiscal Year								
	1994	1995	1996	1997	1998	1999	2000	2001**	
Less than 3%	4,287	4,121	3,837	3,798	3,722	3,347	2,998	2,564	-40.2
3-50% and R&D spending \$3 million or more	131	143	145	163	187	212	221	228	74.0
3-50% and R&D spending less than \$3 million	4,981	4,957	4,504	4,449	4,454	4,314	3,826	4,109	-17.5
Greater than 50%	1,733	1,551	1,319	1,240	1,421	2,095	3,373	1,992	14.9
Total	11,132	10,772	9,805	9,650	9,784	9,968	10,418	8,893	-20.1

*R&D spending as percent of revenue

**Preliminary numbers

Note: may not add due to rounding

Table A2. Revenue by Research Intensity Level, 1994-2001
All Companies

Research Intensity* Level	Revenue (\$Million)								% Change 1994-2001
	Fiscal Year								
	1994	1995	1996	1997	1998	1999	2000	2001**	
Less than 3%	\$413,232.3	\$457,162.4	\$427,123.3	\$436,771.8	\$491,913.3	\$487,430.4	\$484,052.3	\$441,408.6	6.8
3-50% and R&D spending \$3 million or more	\$31,986.6	\$28,420.9	\$28,760.8	\$36,932.7	\$39,799.0	\$48,761.7	\$61,985.2	\$74,958.9	134.3
3-50% and R&D spending less than \$3 million	\$10,883.3	\$11,948.0	\$10,707.9	\$10,901.7	\$10,787.9	\$11,811.7	\$11,475.8	\$11,228.2	3.2
Greater than 50%	\$1,196.5	\$1,208.6	\$1,222.6	\$1,247.9	\$921.9	\$1,083.2	\$2,632.9	\$2,847.2	138.0
Total	\$457,298.7	\$498,739.8	\$467,814.7	\$485,854.1	\$543,422.0	\$549,087.1	\$560,146.2	\$530,443.0	16.0

*R&D spending as percent of revenue

**Preliminary numbers

Note: may not add due to rounding

Table A3. R&D Spending by Research Intensity Level, 1994-2001
All Companies

Research Intensity* Level	R&D Spending (\$Million)								% Change 1994-2001
	Fiscal Year								
	1994	1995	1996	1997	1998	1999	2000	2001**	
Less than 3%	\$1,905.2	\$2,073.7	\$1,971.9	\$1,867.9	\$1,913.3	\$1,825.9	\$1,805.3	\$1,856.7	-2.5
3-50% and R&D spending \$3 million or more	\$3,271.3	\$3,431.1	\$3,680.0	\$4,458.2	\$5,380.4	\$5,880.4	\$7,120.3	\$7,789.5	138.1
3-50% and R&D spending less than \$3 million	\$1,024.2	\$1,128.1	\$995.1	\$1,006.2	\$1,011.7	\$1,110.6	\$1,132.5	\$1,188.0	16.0
Greater than 50%	\$1,366.5	\$1,357.6	\$1,349.0	\$1,408.6	\$1,365.6	\$1,577.1	\$2,116.4	\$2,344.9	71.6
Total	\$7,567.2	\$7,990.6	\$7,996.0	\$8,740.8	\$9,671.0	\$10,394.1	\$12,174.5	\$13,179.1	74.2

*R&D spending as percent of revenue

**Preliminary numbers

Note: may not add due to rounding

**Table A4. Research Intensity* by Research Intensity Level, 1994-2001
All Companies**

Research Intensity* Level	Research Intensity (%)								% Change 1994-2001
	Fiscal Year								
	1994	1995	1996	1997	1998	1999	2000	2001**	
Less than 3%	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	-8.8
3-50% and R&D spending \$3 million or more	10.2	12.1	12.8	12.1	13.5	12.1	11.5	10.4	1.6
3-50% and R&D spending less than \$3 million	9.4	9.4	9.3	9.2	9.4	9.4	9.9	10.6	12.4
Greater than 50%	114.2	112.3	110.3	112.9	148.1	145.6	80.4	82.4	-27.9
Total	1.7	1.6	1.7	1.8	1.8	1.9	2.2	2.5	50.1

*R&D spending as percent of revenue
**Preliminary numbers

**Table A5. Total Employees by Research Intensity Level, 1994-2001
All Companies**

Research Intensity* Level	Total Employees (#)								% Change 1994-2001
	Fiscal Year								
	1994	1995	1996	1997	1998	1999	2000	2001**	
Less than 3%	1,427,830	1,412,708	1,250,121	1,292,953	1,296,202	1,184,681	1,136,378	1,009,690	-29.3
3-50% and R&D spending \$3 million or more	140,371	124,542	119,603	137,711	149,855	165,538	192,821	208,081	48.2
3-50% and R&D spending less than \$3 million	98,693	105,568	97,055	100,352	95,394	106,609	102,250	99,912	1.2
Greater than 50%	23,701	29,049	24,219	26,123	41,861	59,318	80,880	58,782	148.0
Total	1,690,595	1,671,867	1,490,998	1,557,139	1,583,312	1,516,146	1,512,329	1,376,465	-18.6

*R&D spending as percent of revenue
**Preliminary numbers
Note: may not add due to rounding

**Table A6. R&D Employees⁺ by Research Intensity Level, 1994-2001
All Companies**

Research Intensity* Level	R&D Employees (#)								% Change 1994-2001
	Fiscal Year								
	1994	1995	1996	1997	1998	1999	2000	2001**	
Less than 3%	20,304	22,138	19,913	18,907	18,545	17,166	16,505	15,403	-24.1
3-50% and R&D spending \$3 million or more	25,870	25,287	27,443	31,253	34,707	36,910	43,281	42,235	63.3
3-50% and R&D spending less than \$3 million	18,058	19,962	18,028	18,246	18,635	20,561	20,826	22,156	22.7
Greater than 50%	14,651	14,626	13,960	14,287	13,880	16,183	20,280	20,864	42.4
Total	78,883	82,013	79,344	82,693	85,767	90,820	100,892	100,658	27.6

+Full-time equivalent only
*R&D spending as percent of revenue
**Preliminary numbers
Note: may not add due to rounding

Appendix B: Detailed Tables by Research Intensity Level Sector, 1994-2001

Table B1. Number of Companies, ICT

Table B2. Revenue, ICT

Table B3. R&D Spending, ICT

Table B4. Research Intensity, ICT

Table B5. Total Employees, ICT

Table B6. R&D Employees, ICT

Table B7. Number of Companies, Pharmaceuticals/Medicine Manufacturing

Table B8. Revenue, Pharmaceuticals/Medicine Manufacturing

Table B9. R&D Spending, Pharmaceuticals/Medicine Manufacturing

Table B10. Research Intensity, Pharmaceuticals/Medicine Manufacturing

Table B11. Total Employees, Pharmaceuticals/Medicine Manufacturing

Table B12. R&D Employees, Pharmaceuticals/Medicine Manufacturing

Table B13. Number of Companies, Aerospace

Table B14. Revenue, Aerospace

Table B15. R&D Spending, Aerospace

Table B16. Research Intensity, Aerospace

Table B17. Total Employees, Aerospace

Table B18. R&D Employees, Aerospace

Table B1. Number of Companies by Research Intensity Level, 1994-2001
ICT Sector

Research Intensity* Level	Number of Companies (#)								% Change 1994-2001
	Fiscal Year								
	1994	1995	1996	1997	1998	1999	2000	2001**	
Less than 3%	394	360	389	397	352	304	296	234	-40.6
3-50% and R&D spending \$3 million or more	53	61	58	76	85	94	109	119	124.5
3-50% and R&D spending less than \$3 million	1,587	1,584	1,538	1,551	1,549	1,436	1,352	1,380	-13.0
Greater than 50%	544	496	434	408	483	603	952	659	21.1
Total	2,578	2,501	2,419	2,432	2,469	2,437	2,709	2,392	-7.2

*R&D spending as percent of revenue

**Preliminary numbers

Note: may not add due to rounding

Table B2. Revenue by Research Intensity Level, 1994-2001
ICT Sector

Research Intensity* Level	Revenue (\$Million)								% Change 1994-2001
	Fiscal Year								
	1994	1995	1996	1997	1998	1999	2000	2001**	
Less than 3%	\$24,130.0	\$36,441.4	\$40,926.5	\$37,288.8	\$38,313.4	\$38,012.1	\$29,088.3	\$28,732.8	19.1
3-50% and R&D spending \$3 million or more	\$17,067.8	\$12,140.1	\$10,967.4	\$15,628.4	\$18,198.6	\$19,496.8	\$35,316.7	\$39,345.7	130.5
3-50% and R&D spending less than \$3 million	\$3,563.5	\$3,940.2	\$3,729.6	\$3,631.3	\$3,793.3	\$3,828.1	\$4,653.3	\$4,297.8	20.6
Greater than 50%	\$560.4	\$594.6	\$632.9	\$691.4	\$326.5	\$268.9	\$274.4	\$456.8	-18.5
Total	\$45,321.7	\$53,116.2	\$56,256.4	\$57,239.9	\$60,631.8	\$61,605.9	\$69,332.7	\$72,833.0	60.7

*R&D spending as percent of revenue

**Preliminary numbers

Note: may not add due to rounding

Table B3. R&D Spending by Research Intensity Level, 1994-2001
ICT Sector

Research Intensity* Level	R&D Spending (\$Million)								% Change 1994-2001
	Fiscal Year								
	1994	1995	1996	1997	1998	1999	2000	2001**	
Less than 3%	\$164.2	\$341.4	\$360.8	\$340.8	\$345.7	\$373.0	\$171.2	\$383.5	133.5
3-50% and R&D spending \$3 million or more	\$2,003.7	\$1,978.3	\$2,018.3	\$2,380.0	\$3,131.3	\$3,316.0	\$4,719.6	\$4,917.1	145.4
3-50% and R&D spending less than \$3 million	\$410.2	\$454.4	\$422.0	\$415.8	\$440.0	\$444.4	\$540.4	\$540.7	31.8
Greater than 50%	\$455.1	\$482.4	\$535.3	\$526.7	\$335.9	\$326.2	\$706.9	\$730.8	60.6
Total	\$3,033.2	\$3,256.5	\$3,336.3	\$3,663.3	\$4,252.8	\$4,459.6	\$6,138.1	\$6,572.1	116.7

*R&D spending as percent of revenue

**Preliminary numbers

Note: may not add due to rounding

**Table B4. Research Intensity* by Research Intensity Level, 1994-2001
ICT Sector**

Research Intensity* Level	Research Intensity (%)								% Change 1994-2001
	Fiscal Year								
	1994	1995	1996	1997	1998	1999	2000	2001**	
Less than 3%	0.7	0.9	0.9	0.9	0.9	1.0	0.6	1.3	96.1
3-50% and R&D spending \$3 million or more	11.7	16.3	18.4	15.2	17.2	17.0	13.4	12.5	6.5
3-50% and R&D spending less than \$3 million	11.5	11.5	11.3	11.5	11.6	11.6	11.6	12.6	9.3
Greater than 50%	81.2	81.1	84.6	76.2	102.9	121.3	257.6	160.0	97.0
Total	6.7	6.1	5.9	6.4	7.0	7.2	8.9	9.0	34.8

*R&D spending as percent of revenue
**Preliminary numbers

**Table B5. Total Employees by Research Intensity Level, 1994-2001
ICT Sector**

Research Intensity* Level	Total Employees (#)								% Change 1994-2001
	Fiscal Year								
	1994	1995	1996	1997	1998	1999	2000	2001**	
Less than 3%	122,251	146,073	154,771	135,833	129,994	134,629	97,902	107,793	-11.8
3-50% and R&D spending \$3 million or more	71,117	60,513	50,792	57,581	69,669	72,188	99,743	101,237	42.4
3-50% and R&D spending less than \$3 million	32,600	34,562	35,572	32,951	34,062	36,116	40,517	37,411	14.8
Greater than 50%	7,954	8,101	8,535	10,878	10,598	11,601	17,157	16,019	101.4
Total	233,922	249,249	249,670	237,243	244,323	254,534	255,319	262,460	12.2

*R&D spending as percent of revenue
**Preliminary numbers
Note: may not add due to rounding

**Table B6. R&D Employees⁺ by Research Intensity Level, 1994-2001
ICT Sector**

Research Intensity* Level	R&D Employees (#)								% Change 1994-2001
	Fiscal Year								
	1994	1995	1996	1997	1998	1999	2000	2001**	
Less than 3%	1,940	3,806	3,569	3,051	2,699	3,064	2,103	2,621	35.1
3-50% and R&D spending \$3 million or more	16,846	16,165	17,057	20,136	23,077	24,290	28,349	27,021	60.4
3-50% and R&D spending less than \$3 million	7,542	8,487	8,132	8,208	8,851	9,323	10,744	10,993	45.8
Greater than 50%	5,216	5,103	5,564	5,592	4,458	4,282	6,497	7,461	43.0
Total	31,544	33,561	34,322	36,987	39,085	40,959	47,693	48,096	52.5

+Full-time equivalent only
*R&D spending as percent of revenue
**Preliminary numbers
Note: may not add due to rounding

**Table B7. Number of Companies by Research Intensity Level, 1994-2001
Pharmaceutical/Medicine Manufacturing Sector**

Research Intensity* Level	Number of Companies (#)								% Change 1994-2001
	Fiscal Year								
	1994	1995	1996	1997	1998	1999	2000	2001**	
Less than 3%	28	23	19	25	25	14	20	15	-46.4
3-50% and R&D spending \$3 million or more	17	19	17	17	16	17	15	18	5.9
3-50% and R&D spending less than \$3 million	28	22	30	32	32	25	30	30	7.1
Greater than 50%	10	9	14	9	13	18	26	21	110.0
Total	83	73	80	83	86	74	91	84	1.2

*R&D spending as percent of revenue

**Preliminary numbers

Note: may not add due to rounding

**Table B8. Revenue by Research Intensity Level, 1994-2001
Pharmaceutical/Medicine Manufacturing Sector**

Research Intensity* Level	Revenue (\$Million)								% Change 1994-2001
	Fiscal Year								
	1994	1995	1996	1997	1998	1999	2000	2001**	
Less than 3%	\$2,355.7	\$2,369.9	\$1,200.4	\$2,559.3	\$2,667.9	\$1,171.7	\$2,376.4	\$1,535.6	-34.8
3-50% and R&D spending \$3 million or more	\$3,305.1	\$3,860.9	\$4,197.3	\$4,539.8	\$4,561.7	\$5,842.2	\$4,977.8	\$6,668.6	101.8
3-50% and R&D spending less than \$3 million	\$236.5	\$196.4	\$225.8	\$206.9	\$179.3	\$122.9	\$233.0	\$176.4	-25.4
Greater than 50%	\$18.5	\$25.1	\$33.7	\$38.8	\$41.6	\$74.4	\$97.1	\$96.1	419.1
Total	\$5,915.8	\$6,452.3	\$5,657.2	\$7,344.8	\$7,450.6	\$7,211.2	\$7,684.3	\$8,476.6	43.3

*R&D spending as percent of revenue

**Preliminary numbers

Note: may not add due to rounding

**Table 9B. R&D Spending by Research Intensity Level, 1994-2001
Pharmaceutical/Medicine Manufacturing Sector**

Research Intensity* Level	R&D Spending (\$Million)								% Change 1994-2001
	Fiscal Year								
	1994	1995	1996	1997	1998	1999	2000	2001**	
Less than 3%	\$49.2	\$35.5	\$15.4	\$37.1	\$39.3	\$11.4	\$35.1	\$13.8	-71.9
3-50% and R&D spending \$3 million or more	\$306.0	\$378.9	\$450.9	\$446.4	\$464.7	\$494.7	\$564.6	\$689.6	125.3
3-50% and R&D spending less than \$3 million	\$16.2	\$14.4	\$13.8	\$13.0	\$12.5	\$9.4	\$16.0	\$16.7	3.1
Greater than 50%	\$19.5	\$21.5	\$35.7	\$49.9	\$50.3	\$71.8	\$89.9	\$103.1	427.7
Total	\$391.1	\$450.3	\$515.8	\$546.4	\$566.7	\$587.3	\$705.7	\$823.3	110.5

*R&D spending as percent of revenue

**Preliminary numbers

Note: may not add due to rounding

**Table B10. Research Intensity* by Research Intensity Level, 1994-2001
Pharmaceutical/Medicine Manufacturing Sector**

Research Intensity* Level	Research Intensity (%)								% Change 1994-2001
	Fiscal Year								
	1994	1995	1996	1997	1998	1999	2000	2001**	
Less than 3%	2.1	1.5	1.3	1.5	1.5	1.0	1.5	0.9	-56.9
3-50% and R&D spending \$3 million or more	9.3	9.8	10.7	9.8	10.2	8.5	11.3	10.3	11.7
3-50% and R&D spending less than \$3 million	6.9	7.3	6.1	6.3	7.0	7.6	6.9	9.5	38.2
Greater than 50%	105.6	85.6	106.0	128.7	120.8	96.5	92.6	107.4	1.6
Total	6.6	7.0	9.1	7.4	7.6	8.1	9.2	9.7	46.9

*R&D spending as percent of revenue

**Preliminary numbers

**Table B11. Total Employees by Research Intensity Level, 1994-2001
Pharmaceutical/Medicine Manufacturing Sector**

Research Intensity* Level	Total Employees (#)								% Change 1994-2001
	Fiscal Year								
	1994	1995	1996	1997	1998	1999	2000	2001**	
Less than 3%	6,856	6,848	2,864	5,812	6,381	2,814	7,173	4,255	-37.9
3-50% and R&D spending \$3 million or more	10,790	11,213	11,517	12,482	12,190	16,874	14,046	19,063	76.7
3-50% and R&D spending less than \$3 million	1,633	1,136	1,687	1,720	1,421	952	1,831	1,449	-11.3
Greater than 50%	191	245	333	385	501	878	1,381	1,090	470.7
Total	19,470	19,442	16,401	20,399	20,493	21,518	24,431	25,857	32.8

*R&D spending as percent of revenue

**Preliminary numbers

Note: may not add due to rounding

**Table B12. R&D Employees⁺ by Research Intensity Level, 1994-2001
Pharmaceutical/Medicine Manufacturing Sector**

Research Intensity* Level	R&D Employees (#)								% Change 1994-2001
	Fiscal Year								
	1994	1995	1996	1997	1998	1999	2000	2001**	
Less than 3%	417	341	146	262	279	102	364	120	-71.2
3-50% and R&D spending \$3 million or more	1,635	1,947	1,992	2,088	2,123	2,394	2,596	3,132	91.6
3-50% and R&D spending less than \$3 million	208	159	156	158	187	128	257	251	20.7
Greater than 50%	159	223	283	347	361	505	580	594	273.6
Total	2,419	2,670	2,577	2,855	2,950	3,129	3,797	4,097	69.4

+Full-time equivalent only

*R&D spending as percent of revenue

**Preliminary numbers

Note: may not add due to rounding

**Table B13. Number of Companies by Research Intensity Level, 1994-2001
Aerospace Sector**

Research Intensity* Level	Number of Companies (#)								% Change 1994-2001
	Fiscal Year								
	1994	1995	1996	1997	1998	1999	2000	2001**	
Less than 3%	17	16	22	23	20	14	21	18	5.9
3-50% and R&D spending \$3 million or more	10	10	10	10	11	9	9	9	-10.0
3-50% and R&D spending less than \$3 million	16	17	15	25	26	30	23	22	37.5
Greater than 50%	1	3	7	9	6	11	19	6	500.0
Total	44	46	54	67	63	64	72	55	25.0

*R&D spending as percent of revenue

**Preliminary numbers

Note: may not add due to rounding

**Table B14. Revenue by Research Intensity Level, 1994-2001
Aerospace Sector**

Research Intensity* Level	Revenue (\$Million)								% Change 1994-2001
	Fiscal Year								
	1994	1995	1996	1997	1998	1999	2000	2001**	
Less than 3%	\$829.4	\$977.1	\$1,080.8	\$982.9	\$1,801.9	\$1,516.4	\$2,025.5	\$1,174.7	41.6
3-50% and R&D spending \$3 million or more	\$5,622.5	\$7,175.1	\$8,283.7	\$9,765.3	\$10,001.3	\$10,525.6	\$11,181.4	\$14,617.0	160.0
3-50% and R&D spending less than \$3 million	\$26.2	\$95.5	\$51.0	\$201.6	\$96.5	\$122.7	\$110.5	\$102.2	289.5
Greater than 50%	+	+	\$0.6	\$10.8	\$10.6	+	\$14.5	\$12.6	
Total	\$6,478.2	\$8,247.6	\$9,416.0	\$10,960.7	\$11,910.2	\$12,164.7	\$13,332.0	\$15,906.4	145.5

*R&D spending as percent of revenue

**Preliminary numbers

+1994, 1995 and 1999: revenue and R&D expenditures could not be reported separately due to confidentiality

Note: may not add due to rounding

**Table B15. R&D Spending by Research Intensity Level, 1994-2001
Aerospace Sector**

Research Intensity* Level	R&D Spending (\$Million)								% Change 1994-2001
	Fiscal Year								
	1994	1995	1996	1997	1998	1999	2000	2001**	
Less than 3%	\$5.9	\$4.9	\$6.5	\$8.2	\$21.1	\$18.3	\$27.3	\$8.9	50.2
3-50% and R&D spending \$3 million or more	\$602.6	\$702.8	\$758.1	\$1,020.9	\$1,094.9	\$1,026.4	\$841.8	\$908.2	50.7
3-50% and R&D spending less than \$3 million	\$3.3	\$6.0	\$5.0	\$13.1	\$8.2	\$11.5	\$9.8	\$8.7	164.9
Greater than 50%	+	+	\$1.3	\$8.8	\$7.5	+	\$9.4	\$7.3	
Total	\$611.8	\$713.7	\$770.9	\$1,051.0	\$1,131.8	\$1,056.2	\$888.2	\$933.0	52.5

*R&D spending as percent of revenue

**Preliminary numbers

+1994, 1995 and 1999: revenue and R&D expenditures could not be reported separately due to confidentiality

Note: may not add due to rounding

**Table B16. Research Intensity* by Research Intensity Level, 1994-2001
Aerospace Sector**

Research Intensity* Level	Research Intensity (%)								% Change 1994-2001
	Fiscal Year								
	1994	1995	1996	1997	1998	1999	2000	2001**	
Less than 3%	0.7	0.5	0.6	0.8	1.2	1.2	1.3	0.8	6.0
3-50% and R&D spending \$3 million or more	10.7	9.8	9.2	10.5	10.9	9.8	7.5	6.2	-42.0
3-50% and R&D spending less than \$3 million	12.5	6.3	9.9	6.5	8.5	9.4	8.8	8.5	-32.0
Greater than 50%	+	+	224.1	81.6	70.9	+	64.4	57.8	
Total	9.4	8.7	8.2	9.6	9.5	8.7	6.7	5.9	-37.9

*R&D spending as percent of revenue

**Preliminary numbers

+1994, 1995 and 1999: revenue and R&D expenditures could not be reported separately due to confidentiality

**Table B17. Total Employees by Research Intensity Level, 1994-2001
Aerospace Sector**

Research Intensity* Level	Total Employees (#)								% Change 1994-2001
	Fiscal Year								
	1994	1995	1996	1997	1998	1999	2000	2001**	
Less than 3%	7,063	5,867	6,969	7,068	11,185	10,204	9,307	5,965	-15.5
3-50% and R&D spending \$3 million or more	29,250	29,012	32,916	41,295	39,558	39,975	35,924	40,698	39.1
3-50% and R&D spending less than \$3 million	306	846	601	1,585	903	1,216	1,062	1,046	241.8
Greater than 50%	2	10	30	81	63	1,664	255	134	6,600.0
Total	36,621	35,735	40,516	50,029	51,709	53,059	46,548	47,843	30.6

*R&D spending as percent of revenue

**Preliminary numbers

Note: may not add due to rounding

**Table B18. R&D Employees⁺ by Research Intensity Level, 1994-2001
Aerospace Sector**

Research Intensity* Level	R&D Employees (#)								% Change 1994-2001
	Fiscal Year								
	1994	1995	1996	1997	1998	1999	2000	2001**	
Less than 3%	63	47	72	126	271	179	313	106	68.3
3-50% and R&D spending \$3 million or more	4,350	4,322	4,900	5,256	5,018	4,430	5,513	4,702	8.1
3-50% and R&D spending less than \$3 million	62	109	103	176	164	211	195	161	159.7
Greater than 50%	1	4	14	54	56	529	97	70	6,900.0
Total	4,476	4,482	5,089	5,612	5,509	5,349	6,118	5,039	12.6

+Full-time equivalent only

*R&D spending as percent of revenue

**Preliminary numbers

Note: may not add due to rounding