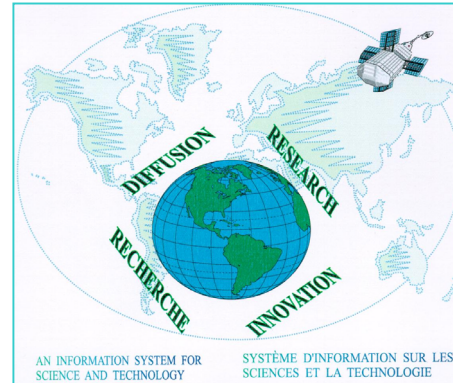


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An Overview of Organisational and Technological Change in the Private Sector, 1998-2000



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**An overview of organisational and technological change
in the private sector, 1998 -2000**

Survey of Electronic Commerce and Technology, 2000

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The Working Papers publish research related to science and technology issues. All papers are subject to internal review. The views expressed in the articles are those of the authors and do not necessarily reflect the views of Statistics Canada.

The Science and Innovation Information Program

The purpose of this program is to develop **useful indicators of science and technology activity** in Canada based on a framework that ties them together into a coherent picture. To achieve the purpose, statistical indicators are being developed in five key entities:

- **Actors:** are persons and institutions engaged in S&T activities. Measures include distinguishing R&D performers, identifying universities that license their technologies, and determining the field of study of graduates.
- **Activities:** include the creation, transmission or use of S&T knowledge including research and development, innovation, and use of technologies.
- **Linkages:** are the means by which S&T knowledge is transferred among actors. Measures include the flow of graduates to industries, the licensing of a university's technology to a company, co-authorship of scientific papers, the source of ideas for innovation in industry.
- **Outcomes:** are the medium-term consequences of activities. An outcome of an innovation in a firm may be more highly skilled jobs. An outcome of a firm adopting a new technology may be a greater market share for that firm.
- **Impacts:** are the longer-term consequences of activities, linkages and outcomes. Wireless telephony is the result of many activities, linkages and outcomes. It has wide-ranging economic and social impacts such as increased connectedness.
-

The development of these indicators and their further elaboration is being done at Statistics Canada, in collaboration with other government departments and agencies, and a network of contractors.

Prior to the start of this work, the ongoing measurements of S&T activities were limited to the investment of money and human resources in research and development (R&D). For governments, there were also measures of related scientific activity (RSA) such as surveys and routine testing. These measures presented a limited picture of science and technology in Canada. More measures were needed to improve the picture.

Innovation makes firms competitive and we are continuing with our efforts to understand the characteristics of innovative and non-innovative firms, especially in the service sector that dominates the Canadian Economy. The capacity to innovate resides in people and measures are being developed of the characteristics of people in those industries that lead science and technology activity. In these same industries, measures are being made of the creation and the loss of jobs as part of understanding the impact of technological change.

The federal government is a principal player in science and technology in which it invests over five billion dollars each year. In the past, it has been possible to say only *how much* the federal government spends and *where* it spends it. Our report **Federal Scientific Activities, 1998 (Cat. No. 88-204)** first published socio-economic objectives indicators to show *what* the S&T money is spent on. As well as offering a basis for a public debate on the priorities of government spending, all of this information has been used to provide a context for performance reports of individual departments and agencies.

As of April 1999, the Program has been established as a part of Statistics Canada's Science, Innovation and Electronic Information Division.

The final version of the framework that guides the future elaboration of indicators was published in December, 1998 (**Science and Technology Activities and Impacts: A Framework for a Statistical Information System**, Cat. No. 88-522). The framework has given rise to **A Five-Year Strategic Plan for the Development of an Information System for Science and Technology** (Cat. No. 88-523).

It is now possible to report on the Canadian system on science and technology and show the role of the federal government in that system.

Our working papers and research papers are available at no cost on the Statistics Canada Internet site at <http://www.statcan.ca/cgi-bin/downpub/research.cgi?subject=193>.

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Preface

Innovation and the adoption and dissemination of technologies and practices are vital to economic growth and development. It is through innovation that new products are introduced to the market, new production processes are developed and introduced, and organisational changes are made. Through the adoption of newer, more advanced, technologies and practices, industries can increase their production capabilities, improve their productivity, and expand their lines of new products and services.

This study is one in a series of studies that the Science, Innovation and Electronic Information Division (SIEID) has undertaken that have examined technological and organisational change in the Canadian economy. In 1993, a first survey of innovation and the adoption of advanced technologies in the manufacturing sector was carried out. It was followed in 1996 by a survey of innovation in the communications, financial services and technical business services industries. The Survey of Innovation 1999 surveyed manufacturing and was the first innovation survey of selected natural resource industries.

Biotechnology surveys carried out in 1996, 1997 and 1999 have examined both the development of new biotechnology products and processes and the use and planned use of biotechnologies. The 1999 Survey of Innovation, Advanced Technologies and Practices in the Construction and Related Industries is the first survey of the innovation and advanced technologies and practices in the construction sector. And finally, a number of surveys have focused on the use and planned use of advanced technologies and practices: surveys of advanced manufacturing technologies were carried out in 1987, 1989, 1993 and 1998; and surveys of the use and planned use of information and communication technologies were carried out in 1999, 2000 and 2001.

The Survey of Electronic Commerce and Technology 2000 contains two questions on organisational and technological improvements. These two questions provide the first cross-economy data on this issue, covering both firms in the private sector and organisations in the public sector. This working paper is the second of several and will examine organisational and technological improvements in the private sector. The first paper in the series looked at organisational and technological improvements in the public sector.

Acknowledgements

This report provides new Statistics Canada estimates of technological and organisational change based on information obtained from the Survey of Electronic Commerce and Technology, 2000. Canada owes the success of its statistical system to a long-standing partnership between Statistics Canada, the citizens of Canada, its businesses, governments and other institutions. Accurate and timely statistical information could not be produced without their continued cooperation and goodwill.

The publication of this report was made possible by the contribution of many people including the methodologists and analysts supporting the Survey of Electronic Commerce and Technology as well as Adele St. Pierre, Mary-Ann Clarke-Wilkinson, Claire Racine-Label, Frances Anderson, Daood Hamdani and Fred Gault.

1. Introduction

Improving organisational structures or implementing new management techniques are indicators of organisational change within firms or organisations. In Canada, between 1998 – 2000, four out of ten private sector firms of all sizes introduced organisational change. When looking at technological change or the introduction of significantly improved technologies for the same period the adoption rate for the private sector stood at 44% (B)¹. Technological change therefore proved more important to the private sector overall than organisational change. However, adoption rates for organisational and technological change are affected by many factors.

This paper is based on information from the 2000 Survey of Electronic Commerce and Technology (SECT) (see Annex 1 for more details on the survey) and explores the rates of adoption of organisational and technological change for the private sector for the time period of 1998-2000. Differences in adoption rates within the goods producing and the services producing sectors will be highlighted. The impact of employment size on adoption rates within the two major sectors will be discussed. Rates for training subsequent to the introduction of organisational or technological change will be presented followed by the type of technological change. Finally, the adoption rates of organisational and technological change by major industrial group within the goods producing and services producing sectors will be presented.

2. Definitions of Organisational and Technological Change

Organisational change is defined by a positive response to this question from SECT, 2000:

“During the last three years, 1998 to 2000, did your organisation introduce significantly improved organisational structures or implement improved management techniques?”

An additional question on training due to organisational change was asked.

“If yes, did these improvements require training?”

The following two questions determined if firms were involved in technological change and, if so, how were they involved:

“During the last three years, 1998 to 2000, did your organisation introduce significantly improved technologies?”

“If yes, how did you introduce significantly improved technologies? (*Check all that apply*)

∂ by purchasing off-the-shelf technologies?

∂ by licensing new technologies?

¹ Data quality indicators are described in Annex 1: Methodological Note.

- ∂ by customising or significantly modifying existing technologies?
- ∂ by developing new technologies? (either alone or in conjunction with others)”

An additional question on training due to technological change overall was asked. (The question did not refer specifically to the type of technological change.)

“Did any of these improvements require training?”

3. Sector Influence on Adoption Rates for Organisational and Technological Change

For the goods producing sector (see tables), 44% (B) of firms made organisational improvements through introducing significantly improved organisational structures or implementing improved management techniques. However, within the goods producing sector, the difference in adoption rates for organisational change fluctuated from a low of 23% (C) in forestry, fishing and hunting to a high of 50% (B) in manufacturing. Firms in manufacturing accounted for three-quarters of firms within the goods producing sector and their contribution to the sector is reflected in the high average. Utilities firms also had an above average rate for the sector with an adoption rate for organisational change of 46% (D). However, utilities firms comprised less than 2% of firms in the goods producing sector, therefore their above average adoption rate had little impact on the goods producing sector’s average.

Overall firms in the services producing sector had a lower adoption rate for organisational change at 38% (B) than their goods producing counterparts. The services producing sector can be further sub-divided into goods related services and intangibles services (see notes Table 1). Just over two-thirds of firms in the services producing sector provide intangible services. The similarity in the adoption rate of organisational change between goods related services (37% B) and intangible services (38% B) is striking with just a percentage point between them.

Within the services producing sector both the highest and lowest rates of adoption of organisational change fell within intangible services (see Table 2). For intangible services the adoption rates for organisational change ranged from a low of 21% (C) for firms in management of companies and enterprises to 52% (D) for educational services and information and cultural industries. In fact, the two private sector industries with public sector counterparts – educational services and health care and social assistance - were amongst the top three industries that underwent organisational change between 1998 and 2000.

Within the goods related services, the adoption rate for organisational change ranged from 28% (C) for transportation and warehousing to 46% (C) for wholesale trade with retail trade (36% B) in the middle.

Table 1. Adoption rates for organisational and technological change, 1998-2000

	Organisational Change Adoption Rate	Technological Change Adoption Rate
Total Private Sector	38.3% B	43.6% B
Total Goods Producing Sector	44.2% B	45.6% B
Total Services Producing Sector	37.6% B	43.4% B
Goods Related Services	37.0% B	38.7% B
Intangible Services	37.9% B	45.5% B
0 Full-time Employees¹		
Private Sector	18.1% B	20.4% B
Goods Producing Sector	29.8% C	29.2% C
Services Producing Sector	16.1% B	18.8% B
Goods Related Services	16.9% C	17.5% C
Intangible Services	15.7% B	19.4% B
1+ Full-time Employees		
Private Sector	42.2% B	48.1% B
Goods Producing Sector	48.8% B	50.9% B
Services Producing Sector	41.6% B	47.9% B
Goods Related Services	40.3% B	42.2% B
Intangible Services	42.2% B	50.5% B
1-99 Full-time Employees		
Private Sector	41.1% B	47.1% B
Goods Producing Sector	46.2% B	48.4% B
Services Producing Sector	40.6% B	47.0% B
Goods Related Services	39.1% B	40.8% B
Intangible Services	41.4% B	49.9% B
100-499 Full-time Employees		
Private Sector	81.6% C	84.0% C
Goods Producing Sector	79.2% C	77.4% C
Services Producing Sector	82.5% C	86.5% C
Goods Related Services	84.6% E	96.2% B
Intangible Services	81.3% D	80.7% D
500+ Full-time Employees		
Private Sector	85.5% C	92.3% C
Goods Producing Sector	72.2% C	88.8% B
Services Producing Sector	90.0% C	93.5% C
Goods Related Services	96.0% B	98.8% B
Intangible Services	84.3% E	88.4% E

Source: Survey of Electronic Commerce and Technology, 2000; Statistics Canada.

Note: Estimates for goods producing and services producing sectors were developed by aggregating NAICS classes as outlined below. Goods producing includes NAICS groups: 11 (excluding agriculture), 21, 22, and 31-33. Services producing sector includes NAICS groups: 41, 44-45, 48-49, 51-56, 61-62 (excluding public sector enterprises), 71-72, and 81. Goods related services includes NAICS groups: 41, 44-45, and 48-49. Intangible services includes NAICS groups: 51-56, 61-62 (excluding public sector enterprises) 71-72 and 81. Taken together goods related services and intangible services aggregate to the services producing sector.

¹The category 0 full-time employees represents a sub-set of the self-employed in Canada and should not be interpreted as representing all of the self-employed. Statistics Canada has implemented guidelines to protect small enterprises from response burden. Also, enterprises that employ part-time employees but not full-time employees would be counted as 0 full-time employee enterprises.

Table 2. Organisational and technological change by sector

	Organisational Change	Technological Change
	%	%
Total private sector	38.3 B	43.6 B
<i>Goods producing sector</i>	<i>44.2 B</i>	<i>45.6 B</i>
Forestry, Fishing and Hunting	22.6 C	27.3 C
Mining and Oil and Gas Extraction	30.2 D	31.5 D
Utilities	46.4 D	64.0 D
Manufacturing	50.2 B	50.6 B
<i>Services producing sector</i>	<i>37.6 B</i>	<i>43.4 B</i>
<i>Goods related services</i>	<i>37.0 B</i>	<i>38.7 B</i>
Wholesale Trade	45.6 C	45.4 C
Retail Trade	35.9 B	37.6 B
Transportation and Warehousing	28.1 C	32.6 C
<i>Intangible Services</i>	<i>37.9 B</i>	<i>45.5 B</i>
Information and Cultural Industries	51.8 D	62.9 C
Finance and Insurance	45.6 C	59.7 C
Real Estate and Rental and Leasing	31.0 B	37.1 B
Professional, Scientific and Technical Services	39.8 B	58.6 B
Management of Companies and Enterprises	21.1 C	30.9 C
Administrative and Support, Waste Management and Remediation Services	48.2 C	53.5 C
Educational Services (excluding public administration)	52.1 D	54.4 D
Health Care and Social Assistance (excluding public administration)	50.2 C	49.5 C
Arts, Entertainment and Recreation	39.4 C	42.3 C
Accommodation and Food Services	29.0 C	29.3 C
Other Services (excluding public administration)	33.4 B	38.3 B

Source: Survey of Electronic Commerce and Technology, 2000; Statistics Canada.

4. Impact of Employment Size on Adoption Rate of Organisational Change

Firm size may impact organisational change adoption rates. According to the Survey of Electronic Commerce and Technology, 2000, within the private sector, almost 90% of firms had less than 20 employees and about 2% of firms contained more than 100 employees. And the adoption rates for organisational change do not increase evenly by employment size. For instance, the organisational change rate for firms without any full-time employees ranked lowest at 18% (B) for the private sector overall. This low adoption rate adversely affected the overall organisational change adoption rate of the private sector. When firms with no full-time employees, that for obvious reasons are less-likely to introduce organisational change, are excluded from the total, the adoption rate for organisational change for the private sector for firms of at least one full-time employee rises to 42% (B) from 38% (B) for the total private sector.

The organisational change rate doubled between enterprises with 1-99 full-time employees and those enterprises with between 100 and 499 full-time employees – moving from 41% (B) to 82% (C). This finding perhaps indicates that organisational change depends in part on the need for formal structures within firms and that smaller firms, based on employment size may have less sophisticated organisational structures in place. Also organisational change impacts on the firms' resources by costing time and

effort that smaller firms may not be as able to afford. Of interest, firms with 1-99 employees in the goods producing sector had a slightly higher adoption rate for organisational change than firms of the same size in the services producing sector with little variation seen between goods related and intangible services. However, a different picture emerges for larger firms of 500 or more employees with a 20 percentage point spread between the organisational change rate recorded in the goods producing sector 72% (C) as compared to the rate of 90% (C) for the services producing sector. And it is within this employment size group that there is a noticeable difference in the adoption rate for organisational change between goods related services at 96% (B) and intangible services 84% (E).

Introducing significantly improved organisational structures or implementing improved management techniques takes on different interpretations depending upon firm size and perhaps to some extent industry. For instance, self-employed individuals or micro-firms would not require the same formal organisational structures and hierarchies as larger enterprises. It is highly unlikely that the self-employed use or would introduce management techniques including self-directed work groups or problem-solving teams or task teams or specialised committees, whereas larger firms do implement these management techniques. For instance, the Workplace Employee Survey (WES), 1998-1999, found that for establishments (as opposed to enterprises) with 500 or more employees, seven out of ten had in place task teams or labour-management committees and five out of ten problem-solving teams. For establishments with 20 to 99 employees, on the other hand, a much lower proportion participated in these activities – 27% had problem-solving teams and 24% task teams or labour-management committees in place (Leckie *et al.*, p.45).

Other types of organisational change can include: integrating different functional areas; modifying the degree of centralisation; downsizing, relying more on temporary and/or part-time workers; re-engineering; increasing over-time hours; adopting flexible working hours; reducing the number of managerial levels; relying on job rotation and/or multi-skilling; implementing Total Quality Management; outsourcing; and collaborating more on interfirm research and development, production or marketing. WES results showed that as employment size increased in establishments, so did the propensity to introduce these types of organisational change. In fact, whereas about four out of ten establishments with less than 20 employees underwent some type of organisational change almost nine out of ten large firms (500 and more employees) implemented some organisational change in 1998-1999 (Leckie *et al.* p.12). Types of organisational change in which the self-employed may have participated include collaborative work, new inventory systems, introducing sub-contracting, new financial management techniques, computerisation of organisational practices, introduction of new corporate strategic orientation or redefining operating hours.² The introduction of these or similar organisational changes could explain in part the 18% adoption rate of organisational change for enterprises with no full-time employees.

² See the **Oslo Manual** (OECD/EUROSTAT,1997), Annex 2 and pp. 54-55 for a discussion of innovative and non-innovative organisational change.

5. Training Provided Due to Organisational Change

Almost three-quarters of enterprises that introduced significantly improved organisational structures or implemented improved management techniques had to train in support of these changes (see Table 3). Large firms were more likely to have provided training to accompany organisational change than were smaller firms with almost all firms of 500+ full-time employees providing training to accompany organisational change as compared to just under three-quarters of firms with less than 100 full-time employees. In fact, the rates of training due to organisational change reported in this paper mirror those recorded by the Workplace Employee Survey (Leckie *et al*, 2001 p. 17). Finally, there was some fluctuation between the training rates in support of organisational change between the goods producing and services producing sectors by employment size group with the goods producing sector generally trailing the services producing sector in provision of training to accompany this type of change. Again, very little variation was seen in the rates for training due to organisational change between goods related services and intangible services. The one instance that showed a noticeable difference in the training rate due to organisational change between goods related services (99% B) and intangible services (86% D) occurred in the 100-499 full-time employees size group. This difference could in part reflect data quality.

Many researchers have found that the incidence for training rises with firm size.³ Betcherman, Leckie and McMullen (Betcherman *et al*, 2000) argue that for many firms training is a cost that needs to be minimised. They found that higher proportions of small firms faced disincentives to training such as lack of government support; loss of trained employees; lack of suitable training facilities and training costs. Level of education within firms is also a factor in providing training. According to the Workplace Employee Survey (WES) and the Adult Education and Training Survey (AETS), employees with higher levels of education are more likely to receive or take training (Leckie *et al*, pp. 22-26 and Statistics Canada, 2001 81-586 p. 88, 92)

Of the goods producing sector, forestry, fishing and hunting had the lowest rate of training due to organisational change at 61% (E). However, both utilities leading at 90% (C) and mining and oil and gas extraction closely following at 87% (C) had extremely high rates of training to accompany organisational change as opposed to the 71% (B) recorded for manufacturing.

In the services producing sector, intangible services with a training rate due to organisational services of 73% (B) stood just 4 percentage points below the goods related services at 77% B. While retail trade had been in the middle of goods related services for

³ See **A Report on Adult Education and Training in Canada** (Statistics Canada, 2001) for information from the 1991, 1993 and 1997 surveys of Adult Education and Training (AETS) that all show rising rates of training as firm size increases (p. 45). Information from the Workplace Employee Survey (Statistics Canada) supports this argument as do the findings published by Betcherman *et al* from the Workplace Training Survey. The AETS also shows that the incidence of workplace training decreases with age and that workers in utilities and finance, insurance and real estate industries had higher participation rates in employer-sponsored training (p. 23 and 75).

introducing organisational change, retailers recorded the highest rate training rate due to organisational change in the goods related services sector at 78% (C). Of interest, in the intangible services, the sectors that together were once known as FIRE (Finance, Insurance and Real Estate) took the end two extremes for training due to organisational change in the services producing sector. Real estate and rental and leasing had the lowest training due to organisational change rate at 67% (C) and finance and insurance the highest at 88% (C). The variation in this rate may be explained in part by the high proportion of firms without any full-time employees in real estate and rental and leasing (37% as opposed to 21% in finance and insurance). When firms without full-time employees are excluded, the difference between the training rates due to organisational change between real estate and rental and leasing (74% C) and finance and insurance (87% C), narrows. Also, during the 1990s and in particular the end of the twentieth century, financial services in Canada were in a period of review and change. In fact, the federal government put into place a Task Force on the Future of the Canadian Financial Services to study issues facing the sector such as economic growth, competition, impacts of technology and regulation. Major banks had undertaken or had proposed mergers and were offering new products such as insurance and leasing through their branches. These organisational changes also may have influenced to some extent the training rates due to organisational change seen in the finance and insurance sector.⁴

6. Technological Change

From 1998 to 2000, four in ten enterprises in the private sector introduced significantly improved technologies. Again, there was little variation in the rate of introduction of technological change between the goods producing and services producing sectors. Within the goods producing sector, almost two-thirds of enterprises in utilities and one-half of enterprises in manufacturing introduced technological change. These rates of adoption of technological change were twice those recorded by the remaining two industries in the goods producing sector. The higher adoption rates for technological change reported in utilities and manufacturing may be due in part to preparation for Year 2000 (Y2K). Ensuring that the Canadian public suffered no interruption in their service for utilities was a high priority in the years leading up to January 1, 2000. Similarly, by June 1999 a very low proportion of manufacturers had taken no steps to ensure that the technology in place would function correctly when the date changed to Year 2000 (Brunet *et al*, 1999).

Work towards ensuring that date dependent technologies functioned in 2000 may have encouraged investments in new machinery and equipment in the late 1990s. In fact, capital expenditures on machinery and equipment experienced a rapid upswing in the late 1990s with projections still indicating continued investment for 2001. However, machinery and equipment repair expenditures appeared to have peaked in 1998 with a slight decline recorded for 1999. Investments in machinery and equipment peaked in

⁴ For more information on the Task Force on the Future of the Canadian Financial Services Sector (also known as the MacKay Report) see <http://finservtaskforce.fin.gc.ca>.

1998 for utilities and manufacturing whereas it peaked one year earlier for mining and oil and gas extraction and agriculture, forestry, fishing and hunting.⁵

Unlike the case of organisational change, the rate of technological change differed between the goods related services (39% B) and intangible services (46% B). As expected the extremes for adoption of new or significantly improved technologies occurred in the intangible services. The highest adoption rates for technological change not surprisingly were in information and cultural industries (63% C) and finance and insurance (60% C). Once again, these higher rates for adoption of technological change could have been influenced in part by Y2K concerns. The financial and insurance sector has invested heavily in interactive secure financial systems and much concern was expressed in the years prior to Y2K about the security of banking and payroll systems. Finance and insurance companies actively participated in preparing and testing their systems for Y2K and showed high level of confidence in mid-1999 that their systems would work January 1, 2000 (Brunet *et al*, 1999). Investments in new machinery and equipment by enterprises in finance and insurance peaked in 1998 but remained high in 1999. For information and cultural industries, projections for expenditures in 2001 far overshadow the steady increases seen from 1997 to 2000 for expenditures on new machinery and equipment (CANSIM 11500).

The intangible services with the lowest technological change rates were accommodation and food services (29% C) and management of companies and enterprises (31% C). Interestingly enough, since 1998 investment in machinery and equipment by management of companies and enterprises has been declining. For accommodation and food services investments in machinery and equipment hit a peak in 1998 and declined through 1999 and 2000. Intentions for 2001, on the other hand, are up. While not all machinery and equipment contained date sensitive technologies, the pattern for investments in new machinery and equipment prior to the Y2K suggests that many enterprises used this period to renew their equipment.

In the goods related services, wholesale trade once again led the three sectors with 45% (C) of wholesalers introducing new or significantly improved technologies between 1998 and 2000.

7. Training Due to Technological Change

The training rates for private sector enterprises that underwent technological change in the period of 1998 to 2000 stood at 72% (B), a similar level to that recorded for organisational change, although the adoption rate for technological change was slightly higher – 44% (B) versus 38% (B). Once again, the goods producing sector and the services producing sector showed little variation in training rates in support of

⁵ CANSIM MATRIX 11500, Capital and Repair Expenditures – The data used are based on the North American Industrial Classification System. Note: The Survey of Electronic Commerce and Technology excluded agriculture. Therefore, readers should use caution in interpreting the peak of investment in machinery and equipment for agriculture, forestry, fishing and hunting with the adoption rates of new technologies by forestry, fishing and hunting.

technological change (Table 3). Training intensity increased with firm size with a marked jump occurring between the rate recorded for firms with 1-99 full-time employees as opposed to those firms with 100-499 full-time employees: 72% (B) to 95% (B). Almost every enterprise with more than 500 full-time employees provided training to accompany technological change.

Table 3. Training rates due to organisational and technological change, 1998-2000

	Organisational Change Training Rate	Technological Change Training Rate
Total Private Sector	73.5% B	72.4% B
Total Goods Producing Sector	70.4% B	71.4% B
Total Services Producing Sector	74.0% B	72.5% B
Goods Related Services	77.2% B	76.7% B
Intangible Services	72.5% B	71.0% B
0 Full-time Employees		
Private Sector	72.1% C	62.0% C
Goods Producing Sector	75.6% D	64.6% D
Services Producing Sector	71.0% C	61.3% C
Goods Related Services	81.5% D	64.1% E
Intangible Services	66.3% D	60.3% D
1 + Full-time employees		
Private Sector	73.7% B	73.3% B
Goods Producing Sector	69.4% B	72.6% B
Services Producing Sector	74.2% B	73.3% B
Goods Related Services	76.9% B	77.5% B
Intangible Services	73.0% B	71.7% B
1-99 Full-time Employees		
Private Sector	72.8% B	72.2% B
Goods Producing Sector	66.8% B	69.7% B
Services Producing Sector	73.4% B	72.4% B
Goods Related Services	75.5% B	76.2% B
Intangible Services	72.4% B	70.9% B
100-499 Full-time Employees		
Private Sector	89.8% C	94.8% B
Goods Producing Sector	85.6% C	92.2% B
Services Producing Sector	91.2% C	95.6% B
Goods Related Services	99.3% B	98.0% B
Intangible Services	86.1% D	93.9% C
500+ Full-time Employees		
Private Sector	96.7% B	98.8% B
Goods Producing Sector	91.7% B	98.0% B
Services Producing Sector	98.0% B	99.1% B
Goods Related Services	98.6% B	99.2% B
Intangible Services	97.5% B	98.9% B

Source: Survey of Electronic Commerce and Technology, 2000; Statistics Canada.

Table 4. Training due to organisational and technological change by sector

	Training due to Organisational Change	Training due to Technological Change
	%	%
Total private sector	73.6 B	72.4 B
<i>Goods producing sector</i>	70.4 B	71.4 B
Forestry, Fishing and Hunting	60.7 E	F
Mining and Oil and Gas Extraction	87.4 C	66.5 E
Utilities	90.2 C	96.4 B
Manufacturing	70.5 B	73.4 B
<i>Services producing sector</i>	74.0 B	72.5 B
<i>Goods related services</i>	77.2 B	76.7 B
Wholesale Trade	76.3 C	80.0 C
Retail Trade	78.2 C	77.5 C
Transportation and Warehousing	75.8 D	68.0 D
<i>Intangible Services</i>	72.5 B	70.9 B
Information and Cultural Industries	67.8 D	68.2 D
Finance and Insurance	87.5 C	88.5 C
Real Estate and Rental and Leasing	66.9 C	67.7 C
Professional, Scientific and Technical Services	70.4 C	65.2 C
Management of Companies and Enterprises	70.1 E	58.2 E
Administrative and Support, Waste Management and Remediation Services	70.5 D	76.4 C
Educational Services (excluding public administration)	72.4 D	70.4 D
Health Care and Social Assistance (excluding public administration)	78.5 C	81.1 C
Arts, Entertainment and Recreation	74.4 D	75.4 D
Accommodation and Food Services	75.8 C	72.4 C
Other Services (excluding public administration)	67.8 C	65.3 C

Source: Survey of Electronic Commerce and Technology, 2000; Statistics Canada.

Utilities had the highest rate for training due to technological change at 96% (B) for both the goods producing and services producing sectors (see Table 4). This suggests that the new or significantly improved technologies introduced differed sufficiently from the technologies that had been in place to require training. Within the goods producing sector, manufacturing again ranked second at 73% (B). However, two-thirds of enterprises in mining and oil and gas extractions also provided training to accompany technological change.

Within the services producing sector, goods related services showed a slightly higher tendency to train to accompany new technologies (77% B) than intangible services (71% B). Of the goods related services, wholesalers had the highest propensity to accompany new technology with training with four out of five wholesalers that introduced new technology offering training. This finding is in contrast to their lower rate of training to accompany significantly improved organisational structures or improved management techniques. Within intangible services nine out of ten finance and insurance firms accompanied technological change with training. This suggests that finance and insurance firms between 1998 and 2000 wanted to be assured that their employees could use the new or significantly modified technologies that they had introduced. Again this

might relate to the Y2K phenomenon that significantly affected these firms. Firms in health care and social assistance also showed a high propensity to train after the introduction of new or significantly improved technologies. As the technologies used in health care are often quite sophisticated and unique to the sector, the high training rate seems complementary to the types of technologies that might have been introduced. Once again, management of companies and enterprises recorded one of the lowest rates for training in this case due to technological change at 58% E.

8. Methods of Introducing Technological Change

Four methods of introducing technological change are available from the Survey of Electronic Commerce and Technology, 2000. These are purchasing off-the-shelf technologies; licensing of new technologies; customising or significantly modifying existing technologies and developing new technologies (either alone or in conjunction with others).⁶

9. Purchasing Off-The-Shelf Technologies Most Important Method Used to Introduce New or Improved Technologies

Not surprisingly, introducing off-the-shelf technologies was the most popular of the methods used to introduce technological change with the private sector (see Table 5). In fact, three-quarters of private sector enterprises that introduced technological change purchased off-the-shelf technologies (70% B for goods producing and 73% B for services producing sectors). Customising or significantly modifying existing technologies ranked second at 41% (B) for the private sector, however, the goods producing sector led at 49% (B) as compared to 40% (B) for the services producing sector. Overall, the private sector's rate of usage of licensing new technologies and developing new technologies fell off to 15% (B) and 18% (B) respectively. Again the goods producing sector had a slightly higher usage rate for developing new technologies at 21% (B) than the services producing sector (18% B). For the goods producing sector, the higher usage rates for customising technologies and developing new technologies by manufacturing and utilities positively impacted the adoption rates for the goods producing sector. These higher rates also may reflect in part the uniqueness of these industries that requires them to create or customise technologies.

⁶ Enterprises that introduced significantly improved technologies solely through leasing would not have been able to respond to the questions on methods of introducing technologies.

Table 5. Adoption rates by method used to introduce technology – enterprises that introduced new technologies

	Off-the-Shelf Purchases	Licensing New Technologies	Customising or Significantly Modifying Existing Technologies	Developing New Technologies
	%	%	%	%
Total private sector	72.6 B	14.6 B	41.2 B	18.2 B
<i>Goods producing sector</i>	<i>69.9 B</i>	<i>15.5 B</i>	<i>48.5 B</i>	<i>21.2 B</i>
Forestry, Fishing and Hunting	F	F	F	5.8% D
Mining and Oil and Gas Extraction	58.4 E	15.1 C	49.4 E	31.5 E
Utilities	64.3 D	19.4 B	54.3 C	15.5 C
Manufacturing	70.8 D	14.8 B	51.0 B	22.8 B
<i>Services producing sector</i>	<i>73.0 B</i>	<i>14.5 B</i>	<i>40.4 B</i>	<i>17.9 B</i>
<i>Goods related services</i>	<i>67.8 B</i>	<i>13.6 B</i>	<i>45.9 B</i>	<i>17.8 B</i>
Wholesale Trade	68.6 C	14.8 C	47.4 C	19.2 C
Retail Trade	67.0 C	13.5 B	45.4 C	10.0 B
Transportation and Warehousing	68.5 D	11.4 C	44.5 D	11.8 C
<i>Intangible Services</i>	<i>75.0 B</i>	<i>14.9 B</i>	<i>38.2 B</i>	<i>17.9 B</i>
Information and Cultural Industries	72.5 D	14.2 C	51.6 D	29.2 D
Finance and Insurance	64.6 D	25.1 C	52.5 D	22.7 C
Real Estate and Rental and Leasing	70.8 C	9.7 C	32.5 C	15.2 C
Professional, Scientific and Technical Services	78.4 B	16.6 B	33.3 C	21.6 B
Management of Companies and Enterprises	87.8 D	14.4 D	21.2 E	14.2 D
Administrative and Support, Waste Management and Remediation Services	76.2 C	22.8 C	54.0 D	36.0 D
Educational Services (excluding public administration)	80.8 D	19.8 D	37.5 D	22.0 D
Health Care and Social Assistance (excluding public administration)	78.2 C	9.3 B	40.6 C	9.3 B
Arts, Entertainment and Recreation	72.2 D	9.6 C	46.4 D	13.4 C
Accommodation and Food Services	66.9 C	16.6 C	42.6 D	7.7 C
Other Services (excluding public administration)	76.1 C	10.6 B	30.2 C	11.7 B

Source: Survey of Electronic Commerce and Technology, 2000; Statistics Canada.

10. Methods Used to Introduce New Technologies by the Services Producing Sector

The rates for purchasing off-the-shelf technologies ranged from a low of 65% (D) for finance and insurance to a high of 88% (D) for management of companies and enterprises. However, enterprises in management of companies and enterprises were the least likely to have customised or significantly modified existing technologies at 21% (E) (the usage rate for this category was highest for administrative and support, waste management and remediation services at 54% D). Finance and insurance showed a slight preference towards licensing with 25% (C) of enterprises that adopted technological change using this method. The least frequent users of licensing were enterprises in health care and social assistance at 9% (B) closely followed at 10% (C) by arts, entertainment and recreation and real estate and rental and leasing. The rates for developing new technologies either alone or in conjunction with others ranged from a low of 9% (B) in

health care and social assistance to a high of 36% (D) again in administrative and support, waste management and remediation services.

The high adoption rates by enterprises in administrative and support, waste management and remediation services that undertook technological change for customisation and new development of new technologies suggests that enterprises in this industry have unique technological needs that are not fulfilled by other suppliers. Similarly, the low rates for development of new technologies for health care and social assistance suggest that this industry can readily adopt technologies developed elsewhere and perhaps even developed specifically for the industry.

11. Methods of Introducing Technological Change by Employment Size

The behaviour of small firms (less than 100 full-time employees) differed from that of medium (100-499 full-time employees) and large (500+ employees) in the methods used to introduce technologies between 1998 and 2000 (see Table 6). For instance, small firms were much less likely to opt for the more sophisticated means of introducing technologies such as licensing, customising existing technologies or developing new technologies. This may be due to the costs versus savings involved in introducing technologies using these methods. For example, small firms may not find it more cost-effective to license software packages than to purchase them. Similarly they may not have the “in-house” expertise or the required cash flow to customise or develop new technologies, unless this type of work is their main activity. Therefore, technology adoption (purchasing off-the-shelf technologies) is very important to small firms.

Technology adoption also ranked high with mid sized firms (100-499 full-time employees) and large firms (500+ full-time employees). Technology adaptation – customising or significantly modifying existing technologies – although relatively important to small firms (less than 100 full-time employees) with about four in ten using this method to introduce new or improved technologies, was much more important to mid sized and large firms (seven out of ten were adapters). Developing new technologies requires the capacity and resources to create that are often not available to small firms unless as already stated this is one of their main activities.

Licensing involves the transfer of technology between enterprises and creates a linkage between the enterprises. Mid and large firms show a greater involvement in using technology transfer. A form of technology transfer and inter-firm linkage indicator that was not specifically asked in the Survey of Electronic Commerce and Technology is leasing. Leasing new technologies may be popular with firms that strategically may wish to protect against technology obsolescence or try new production processes without committing to the expense of outright purchasing technologies. It is also a well-known method of obtaining machinery and equipment whereas licensing is often associated with patented processes and products.

Table 6. Rates for methods used to introduce new technologies by private sector enterprises by employment size – enterprises that introduced new technologies

	0 Full-time Employees	1 or more Full-time Employees	1-99 Full-time Employees	100-499 Full-time Employees	500+ Full-time Employees
	%	%	%	%	%
Off-the-Shelf Purchases	73.2 C	72.6 B	72.7 B	66.9 C	86.8 C
Licensing of New Technologies	12.5 B	14.8 B	13.8 B	32.5 C	43.6 E
Customising or Significantly Modifying Existing Technologies	37.8 C	41.5 B	40.2 B	67.4 C	70.0 D
Developing New Technologies	13.2 B	18.6 B	17.6 B	36.6 D	47.4 E

Source: Survey of Electronic Commerce and Technology, 2000; Statistics Canada.

12. Conclusions

This paper has presented an overview of organisational and technological change in Canada (from 1998 to 2001). Similar to findings, published elsewhere, on the propensity of firms to train employees, adoption of organisational and technological change also increased with firm size. In fact, the organisational change rate for small firms with 1-19 full-time employees was almost half that of the next employment size group (20-99 full-time employees). The lower adoption rate for organisational and technological change of small firms translates into lower proportions of employees in firms of this size receiving training related to the changes introduced. In fact, small firms recorded lower incidences of training to support either organisational or technological change.

The small differences between rates for organisational and technological change between the goods producing and services producing sectors show an overall symmetry within the economy for these types of change. And when goods related services were contrasted to intangible services, the results for the two sub-aggregations of the services producing sector showed remarkable similarities. However, some striking differences between major industrial groups such as the above average adoption rates for organisational change in manufacturing, educational services as contrasted to the below average adoption rates for organisational change in forestry, fishing and hunting and management of companies and enterprises were highlighted. While forestry, fishing and hunting recorded the lowest rate of technological change in the goods producing sector, accommodation and food services just inched out management of companies and enterprises for this ranking in the services producing sector. Utilities led overall and in the goods producing sector with the highest adoption rate for technological change followed closely by information and cultural industries in the services producing sector.

Firm size played a role in the way technologies were introduced with small firms showing a preference towards purchasing technologies off-the-shelf (technology adoption). While purchasing off-the-shelf technologies was a very important method of introducing technologies for medium and large firms, these firms also showed a higher

frequency of use of other more sophisticated means of introducing technological change such as customising or modifying existing technologies (technology adaptation). Also, large firms had the highest rate for developing new technologies (technology creation).

Firms in the Canadian private sector quite actively engaged in introducing organisational and technological change between 1998 and 2000. Technology adoption, adaptation, transfer and creation are important to firm productivity. Organisational change also plays a role in how well firms operate. Understanding the challenges facing firms operating in today's global economy, particularly how they interact, and their linkages, are all emerging issues.

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Annex 1: Methodological Note

Industries are classified according to the North American Industry Classification System (NAICS).

The 2000 Survey of Electronic Commerce and Technology (SECT) collected information on organisational and technology improvements among private and public sector enterprises. The private sector excludes publicly administered enterprises in education services (NAICS 61), health care and social assistance (NAICS 62) and public administration (NAICS 91 excluding 913 local, municipal and regional public administration). The survey covered all economic sectors, with the exception of agriculture and construction. The findings are based on a sample of approximately 21,000 enterprises with a response rate of 77% representing 93% of economic activity. The collection entity for the survey was the *enterprise*. This differs from production surveys that are typically establishment-based. An enterprise is the “organisational unit of a business that directs and controls the resources relating to its domestic organisation and for which consolidated financial and balance sheet accounts are maintained....” (Statistics Canada, **NAICS**, 1998, p. 9).

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When estimates are published, a scale distinguishes between the various qualities of accuracy. It combines the effect of sampling (using the coefficient of variation) and the imputation rate (each imputation adds to the uncertainty of the results). The coefficient of variation tries to give a relative measure of the error made when using a sample instead of using a census to derive an estimate about the whole population. The imputation rate reflects the amount of imputation that took place to correctly fill and ensure consistency within records. Amongst all records to be imputed, there were some that were incomplete (but partially filled out), some that had invalid response patterns and finally some that did not satisfy edit rules. Many imputation methods were used: imputation using administrative data, historical imputation and donor imputation. Every record was identified and completed in order to change the respondents’ answer by the least amount possible.

Quality Indicator Interpretation

Coefficient of Variation	Imputation Rate			
	0.00 - 0.10	0.10 - 0.33	0.33 - 0.60	0.60 - +++
0.00 – 0.01	A	B	C	F
0.01 – 0.05	B	C	D	F
0.05 – 0.25	C	D	E	F
0.25 – 0.33	D	E	F	F
0.33 – 0.50	E	F	F	F
0.50 - +++	F	F	F	F

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