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Measuring User Innovation in Canadian Manufacturing, 2007

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User information

Symbols

The following standard symbols are used in Statistics Canada publications:

.	not available for any reference period
..	not available for a specific reference period
...	not applicable
0	true zero or a value rounded to zero
0s	value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
p	preliminary
r	revised
x	suppressed to meet the confidentiality requirements of the *Statistics Act*
E	use with caution
F	too unreliable to be published

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Highlights

User innovation is a common activity in Canadian manufacturing plants

This paper uses business data where users are the people in a firm carrying out various activities In 2007, one in five (20.7%) manufacturing plants that had introduced advanced technologies were technology modifiers and an equal proportion (21.8%) were technology developers. Taken together, this provides an indicator for user-innovation with four in ten (42.5%) manufacturing plants that introduced advanced technologies having carried out user-innovation in 2007.

The first survey of user innovation has successfully shown that respondents are able and willing to complete questions on user innovation activities and has resulted in some metrics on this activity.

User innovation is more likely to be carried out continuously when there is a formal program of technology adoption

Almost half (48.0%) of user innovators indicated that they developed new technologies or modified an existing technology occasionally and as part of an informal program of technology adoption. User innovators that carried out user innovation as part of a formal program of technology adoption were twice as likely to carry out these activities continuously rather than occasionally. Both technology developers and technology modifiers that develop or modify technologies as part of a formal program of technology adoption were more likely to carry out user innovation continuously. Those with informal programs of technology adoption were more likely to carry out user innovation on an occasional basis. This suggests that a formal program of technology adoption may promote continuous innovation.

Internal funding is the primary source of funding for user innovation

The vast majority (98.4%) of user innovators fund their user innovation projects internally. Further, three of every four user innovators (76.4%) rely exclusively on internal sources of funding for their user innovation projects.

Technology modifiers are more likely than technology developers to exclusively fund user innovation internally. Almost seven in ten (69.3%) technology developers only indicated internal funding for their user innovation compared to more than eight in ten technology modifiers (83.3%). This suggests that technology developers have more linkages in the innovation system than technology modifiers.

Technology developers are twice as likely as technology modifiers to have multiple sources of funding and are more likely than technology modifiers to have external sources of funding for their user innovation projects.

Cooperation on user innovation projects is common, more so than for innovation in general

Six in ten (60.2%) user innovator respondents cooperated with other plants, firms or institutions to develop new or modify existing technologies, three times the rate of cooperation among innovators in general (21.5%). Cooperation on user innovation projects is more likely among technology developers than modifiers. Technology developers are likely to have a larger number of types of cooperation partners than technology modifiers.

Cooperation creates linkages between user innovators and other actors in the innovation system

More than four out of five technology developers and modifiers cooperated with suppliers, making them the most likely partner for both types of plants and creating linkages in the innovation process.

User innovations are being shared, most commonly at no charge

About one in five (18.0%) user innovators shared their user innovations with other firms or institutions with more than half (53.7%) of these plants choosing to share in order to allow a supplier to build a more suitable final product. The most common way to share for both technology modifiers and technology developers is at no charge.

User innovations are being diffused in the Canadian economy

One in four (26.3%) user innovators indicated that their user innovations were adopted by another manufacturing firm to produce and supply the new or modified technology and one in four (25.3%) indicated their user innovations were adopted by other firms. This evidence of innovation diffusion makes user innovators an important actor in the innovation system.

Use of intellectual property protection appears to increase the likelihood of sharing

More than half (53.3%) of user innovators used some method to protect the intellectual property resulting from their user innovations. Technology developers were more likely to protect the intellectual property, with six in ten (60.3%) respondents indicating they protected the intellectual property resulting from their user innovations compared to less than half (46.4%) of technology modifiers. Technology developers and technology modifiers who shared their user innovations were more likely than plants that did not share to protect their intellectual property. What is not known is whether the user innovation that was shared was protected.

User innovation is more costly for technology developers than for technology modifiers

Information on the most recent user innovation indicates that most user innovation projects took form 2 months to 2 years to complete. Technology developers are more likely than technology modifiers to take upwards of 6 months in elapsed time to complete their most recent project compared to technology modifiers who were more likely than technology developers to take 6 months or less. Further, the average total cost of user innovation (including labour and machinery, equipment, and materials) was 59.7% higher for technology developers compared to technology modifiers.

Measuring User Innovation in Canadian Manufacturing, 2007

by Susan Schaan and Mark Uhrbach

1 Introduction

The purpose of this paper is to provide some metrics for the measurement of user innovation. It will explain what is meant by user innovation and provide background on its measurement at Statistics Canada, drawing attention to some more influential work. Challenges to the measurement of user innovation will be presented. An exploration of user innovation through Statistics Canada's first and recently conducted survey of user innovation will include details on the survey methodology and survey findings. Measurement issues and some lessons learned from the survey will be discussed. The paper will conclude by presenting contributions of this study to understanding user innovation.

Innovation is a vital part of economic growth, development, and competitiveness. The measurement of innovation is therefore important as it provides an indicator of a firm's ability to compete, both nationally and in the global economy, and the health of a country's economy. In order to develop effective policies to support innovation, an understanding of the innovation process is critical. Surveys of innovation have been carried out on an occasional basis in Canada since 1993. These surveys have provided innovation indicators for policy development. There are many innovation activities carried out by firms. Technology acquisition[1] is a specific innovation activity that has long been of interest to policy analysts and academics. The acquisition of newer, more advanced, technologies, can allow firms to increase their production capabilities, improve their productivity, and expand their lines of goods and services.

The acquisition of technology is an indicator of innovation diffusion that is important to measure and analyze. The dynamics of knowledge and technology transfer including the source and the relative importance of these sources are necessary elements to providing an understanding of linkages in the innovation process. The mapping of linkages and knowledge flows has strong innovation policy relevance. This allows analysts to identify actors and activities that should receive policy focus in order to foster desired innovation outcomes. As a result, how firms acquire new technology has implications for the innovation system and the economy. User innovation is one way firms can acquire technologies.

1.1 What is user innovation and how is it measured at Statistics Canada?

Users are firms or individual consumers that expect to benefit from *using* a good or service whereas producers expect to benefit from selling a good or service (von Hippel, 2005). Users can be owners, operators or employees in a firm or individuals in a household. This paper uses business data where users are the people in a firm carrying out various activities. One such activity is technology acquisition.

How a firm acquires technologies is an important aspect of the innovation system. Statistics Canada conducted its first survey of technology use and planned use in 1987 and there were similar surveys in the U.S., Australia and some other countries (Ducharme and Gault, 1992). The finding that Canada did not perform as well as its US counterparts for technology adoption stimulated policy debate and generated interest in the Organization for Economic Cooperation and Development (OECD). The 1993 Survey of Innovation and Advanced Technology

1. There are many relatively synonymous words or phrases that can be used to describe the activity of technology acquisition. Some include: adoption, introduction, bring in, and integration. For the purpose of this paper the word "acquisition" is used as it encompasses the adoption, modification of existing technologies and the creation of new ones.

included questions on innovation and advanced technology on the same questionnaire. Subsequently, distinct questionnaires evolved with a 1996 Survey of Innovation and a 1998 Survey of Advanced Technology in Canadian Manufacturing. The focus in Canada in recent years has been on surveys of innovation, rising from the 2001 federal government's Innovation Strategy (Industry Canada, 2001) which drew heavily from results of Statistics Canada's 1999 Survey of Innovation. Although Statistics Canada carried out surveys of innovation in 2003 and 2005 it was not until 2007 that a survey of advanced technology use would be carried out again.[2]

Manufacturers generate revenues and expect benefits from selling a product (good or service) to users who expect to benefit from its use. Typically, product innovations are viewed as having been developed by manufacturers for commercialization in the marketplace, an assumption that has influenced innovation-related research and activities ranging from how firms organize their research and development to how governments measure innovation and approach policy development for innovative activity. In his book *The Sources of Innovation* (von Hippel, 1988), von Hippel presents an alternate approach to the manufacturer-centric view, demonstrating that innovation occurs in a variety of places in different industries. Through a series of studies he has shown that end-users, material suppliers, and others are the typical sources of innovation in some fields. Innovation occurs as a response to a need in processing activities that would not otherwise be met by existing products.

It is important to understand how user innovation is approached using traditional innovation metrics. Users were included in the list of sources of information for innovation in the first edition of the OECD Oslo Manual (OECD 1992:31) and in subsequent editions (OECD/Eurostat 1997:71 and 2005:81). The third edition elaborates on what is referred to as "inbound diffusion" (OECD/Eurostat 2005:78). As innovations are spread through market and non-market channels during the process of innovation diffusion, they are changed by users and feedback can be supplied to the original innovator. Users have been identified as an important source of information for innovation (Survey of Innovation, 2005) signalling the importance of users in the innovation process.

Innovation, the acquisition and use of advanced technologies and the role of the technology user have been the subject of study for decades (von Hippel, 1988). A firm must have the internal capabilities to successfully acquire new technologies or risk failure (Montgomery and Levine, 1996) and how firms acquire advanced technologies has been found to be as indicator of these technological capabilities (Arundel and Sonntag, 2001).

Technology can be acquired in three ways: by purchasing existing technology; by modifying an existing technology, or by creating a new technology. In their study of advanced manufacturing technologies, Arundel and Sonntag (2001) found that half of advanced manufacturing technology users only purchased their advanced technologies off the shelf (46.1%), one quarter customized or significantly modified existing technologies (25.7%) and one quarter (28.2%) developed new technologies. These technological advancements play a strong role in innovation process.

1.2 The measurement challenge

In the Oslo Manual innovation is defined as:

"…the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations." (OECD/Eurostat, 2005)

To be considered as an innovation, a product must be introduced onto the market and a process, marketing method, or organizational method must have been used in the firm's actual operations. The measurement of the incidence of innovation among firms relies on the identification of this activity. This paper limits its scope to technological innovations which include product and process innovations. Identification of product innovations is clear. A product must be introduced onto the market for it to be considered as a product innovation. Process innovations on the other hand may not be as obvious introducing a degree of nuance. As part of their Innovation Strategy (OECD, 2007), the OECD has begun to explore the issue of "hidden innovation", that is innovation that is not always fully reflected

2. Statistics Canada carried out some advanced technology use surveys in specific subject matter areas including: Functional Foods and Neutraceuticals (2005), Functional Foods and Natural Health Products (2007); Innovation, Advanced Technologies and Practices in the Construction and Related Industries Survey (1998); Survey of Electronic Commerce and Technology (2000-2007); Biotechnology Use and Development Survey (1997, 1999, 2001, 2003, 2005); Survey of Environmental Protection Expenditures (1996, 1998, 2000, 2002, 2004, 2006); Environment Industry Survey (1998, 2000, 2002, 2004).

by traditional indicators of innovation. The National Endowment for Science, Technology and the Arts (NESTA) has looked at the gap between perceived innovation and conventional metrics (NESTA, 2007). Drawing from their work, innovation may be "hidden" when firms combine or modify existing technologies and processes in a new way to create innovative solutions. This activity may not be obvious in the firm, occurring as on the job solutions by users in response to production issues. In the absence of R&D, there is a risk that this may not be recognized as an innovation activity in the firm. Capturing this activity may require an approach that complements the Oslo Manual or elaborates on existing guidelines that explore linkages in the innovation process and the actors involved.

One aspect of measuring linkages in the innovation process and the actors involved includes identifying the developers of innovations. The Oslo Manual (OECD/Eurostat, 2005) recommends three options, that:

- *The innovations were mainly developed by the firm itself.*
- *The innovations were developed by the firm in conjunction with other firms or institutions.*
- *The innovations were mainly developed by other firms or institutions and were adopted by the firm as part of a diffusion process (OECD, 2005).*

Questions aimed at identifying the developers of innovations have been included in recent innovation surveys including Eurostat's CIS3 and CIS4, Statistics Canada's Survey of Innovation 2003 and Survey of Innovation 2005 and the Survey of Advanced Technology 2007. Among the half of manufacturing plants who were process innovators during years 2002 to 2004 (Survey of Innovation, 2005), almost two thirds (64.2%) indicated that the development of their process innovations were mainly by their plant or their firm.

The diffusion of innovations results in benefits for other firms or individuals who make use of the innovation. It is not clear that the role of the technology user would be captured given the options provided for identifying developers of innovations. Identifying the actors in the innovation process, the nature of interactions between actors and how knowledge and technology flows in the system is a challenge that is necessary for a better understanding of the diffusion of innovations. Although traditional innovation surveys collect information on sources of information for innovation, information on the linkages between the developer of innovations and the sources of information would provide insights into how knowledge flows in this system. If users are important actors in the innovation process this has direct relevance to innovation policy and supporting user innovation.

2 Measuring user innovation

2.1 Analytic approach

This paper uses data from the Survey of Advanced Technology 2007 and the Follow-up to the Survey of Advanced Technology 2007. The Survey of Advanced Technology 2007 was sent to a stratified random sample of 9,441 manufacturing and 373 logging statistical establishments. The questionnaire substituted the more familiar term "business unit" which is hereafter referred to as plants in this paper. In order to be considered for sample selection the plant had to have at least 20 employees and have at least $250,000 in revenues.[3]

In the spring of 2008, the former Science, Innovation, and Electronic Information Division of Statistics Canada, in conjunction with subject matter experts, designed a questionnaire, the Follow-up to the Survey of Advanced Technology 2007, to probe the activities of manufacturing firms that indicated they had modified existing technologies or developed new technologies as a means of integrating advanced technologies into their firm.

The analytic approach used in this paper is based on that of Arundel and Sonntag (1999) which categorizes technology adoption by highest level of method used. This approach considers that the degree of effort required for each method increases as the complexity of the introduction method, and resulting need for internal capabilities,

3. Detailed information on the Survey of Advanced Technology 2007 is available at: *http://www.statcan.gc.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SurvId=4223&SurvVer=2&InstaId=14681&InstaVer=4&SDDS=4223&lang=en&db=imdb&adm=8&dis=2*.

increases. These range from minimal for purchasing off-the-shelf technologies to extensive in the case of developing new technologies. All responses to Question 4 from the Survey of Advanced Technology 2007 were assigned to one of three classes depending on the highest level of required internal capabilities resulting in a taxonomy of type of plant:[4]

- **Technology purchaser:** These plants either purchase technologies off-the-shelf, lease technologies off-the-shelf, or license new technologies;
- **Technology modifier**: These plants customize or significantly modify existing technologies; or
- **Technology developer**: These plants develop new technologies (either alone or in conjunction with others).

For example, a plant that indicated it both customized or significantly modified existing technologies and that it developed new technologies was classified as a technology developer. A plant classified as a technology purchaser used only this method and neither customized nor developed new technologies. Plants that modify existing technologies or develop new ones provide an indicator of user-innovation and will be the focus of the analysis in this paper.

The Survey of Advanced Technology 2007 shows that manufacturing plants that introduce advanced technologies are most likely to be technology purchasers with more than one half of plants (57.1%) choosing this method. Four in ten (42.5%) of the plants that introduced advanced technologies were user innovators. These plants are not relying on manufacturers to simply supply them with technologies that they require. Rather, they are active participants in innovation, either modifying existing technologies or developing new ones. One in five (20.7%) manufacturing plants that introduced advanced technologies was a technology modifier and an equal proportion (21.8%) of manufacturing plants were technology developers.[5]

The Follow-up to the Survey of Advanced Technology 2007[6] was designed to explore activities in user-innovative plants. It was sent to a quota sample of manufacturing firms classified as technology modifiers or technology developers according to responses to the Survey of Advanced Technology 2007.[7] In March 2008, 1,750 questionnaires were mailed, 915 to technology modifiers and 869 to technology developers. The response rate was 73.0% with 72.1% of modifiers and 73.9% of technology developers returning questionnaires.

The following sections will present results based predominantly on the Follow-up to the Survey of Advanced Technology 2007 with some findings from the Survey of Advanced Technology 2007. The existence of “hidden” innovations will be explored. Results from the Follow-up to the Survey of Advanced Technology 2007 will be presented, first for user innovators overall and then in more detail. Characteristics of technology modifiers and of technology developers will be presented individually and then compared for these two types of user innovators. Given that the survey used a quota sample approach, results are expressed as a percentage of the total number of plants that responded to the question being analysed rather than being representative of the population. Response rate is provided as an indicator of data quality in Appendix A, Table A.

2.2 Identifying "hidden" innovations

Do traditional innovation surveys adequately capture innovative activities? Results of the Survey of Advanced Technology 2007 raise some questions but are not conclusive. Bearing in mind that user innovation occurs in response to production issues it would be expected that the percentage of process innovators would be larger

4. Question 4 on the Survey of Advanced Technology 2007 also included the option of acquiring technologies through merger or acquisition of another firm with advanced technologies. This option was not included in the 1998 survey and involves a different group of activities than would be involved with off-the-shelf purchase, lease or licensing. It has not been considered in this analysis.
5. The total of technology purchasers, technology modifiers and technology developers is not 100% as the remaining 0.4% of plants acquired technologies through mergers only. The sum of the percentage of technology modifiers and technology developers does not equal the percentage of user innovators due to rounding.
6. Detailed information on the Follow up to the Survey of Advanced Technology 2007 is available at: *http://www.statcan.gc.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SDDS=4223&lang=en&db=imdb&adm=8&dis=2*.
7. Collection for the Survey of Advanced Technology 2007 ran from September 24, 2007 to May 15, 2008. It should be noted that collection for the Survey of Advanced Technology 2007 was ongoing when the quota sample for the Follow-up to the Survey of Advanced Technology 2007 was drawn. As a result, the quota sample of 1,750 user innovators for the Follow-up to the Survey of Advanced Technology 2007 was 67.0% of all user innovators identified by the Survey of Advanced Technology 2007.

than the percentage of user innovators and that user innovators would be a sub-set of process innovators. User innovations that are not a sub-set of process innovations can be described as “hidden” (NESTA, 2007) and would show that traditional innovation survey questions are not completely capturing innovative activities.

Results of the Survey of Advanced Technology 2007 show that the incidence of process innovation among advanced technology users (51.3%) is greater than the incidence of user innovation (42.5%) (Table 1).

Text table 1

Percentage of plants with process innovations during 2004 to 2007 and percentage of user innovators among advanced technology users in 2007

Process innovator	User innovator		Total
	No	Yes	
	percent		
No	32.2	16.5	48.7
Yes	25.3	26.0	51.3
Total	57.5	42.5	100.0

Source(s): Statistics Canada, Survey of Advanced Technology 2007.

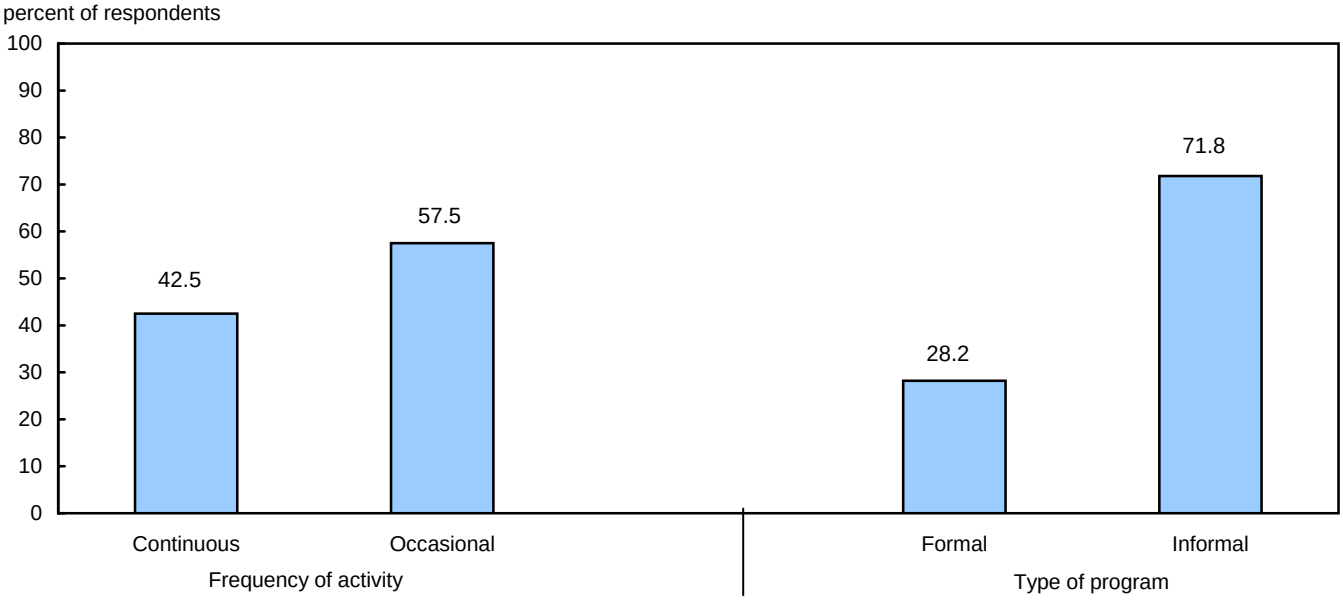
However, among advanced technology users, one in six (16.5%) plants were identified as a user innovator but did not indicate they had a process innovation. In other words, almost four of every ten (38.8%) user innovators did not indicate that they were process innovators. This apparent disconnect agrees with findings of von Hippel and de Jong (2008). Despite this, no conclusions can be drawn as the data have considerable caveats. The Survey of Advanced Technology, 2007 reference period for process innovations was 2004-2007. Any process innovations occurring outside this three year time frame were not captured. There was no reference period for the method of acquisition or integration of advanced technologies. It is not known if the technology was acquired prior to 2004. As a result, any user innovation occurring prior to 2004 would not be a subset of the process innovations from 2004 to 2007. Using the existing data it is not possible to isolate these. Ideally, only user innovations that occurred from 2004 to 2007 should be considered in an examination of their relationship to process innovation rates.

Despite these limitations, the data show that half (50.6%) of process innovators that used advanced technologies had a user innovation and 61.2% of user innovators were process innovators. This highlights the importance of this activity in the innovation process. Understanding the activities of user innovators may help in the formulation of questions that can be used in conjunction with more traditional innovation survey questions to better capture this type of innovative activity and can help identify areas for policy focus for innovation stimulation. Results of the Follow-up to the Survey of Advanced Technology 2007 provide some insights to user innovation activities.

2.3 Activities of user innovators

User innovators are more likely to modify technologies or develop new technologies occasionally than continuously (Chart 1). Responding user innovator plants were two and a half times more likely to carry out technology modification or new technology development as part of an informal rather than as part of a formal program of technology adoption.

Chart 1
Percent of user innovator respondents indicating frequency of development of new technologies or modification of existing technologies[1] and type of technology adoption program under which the development or modification is carried out in their plant[2]



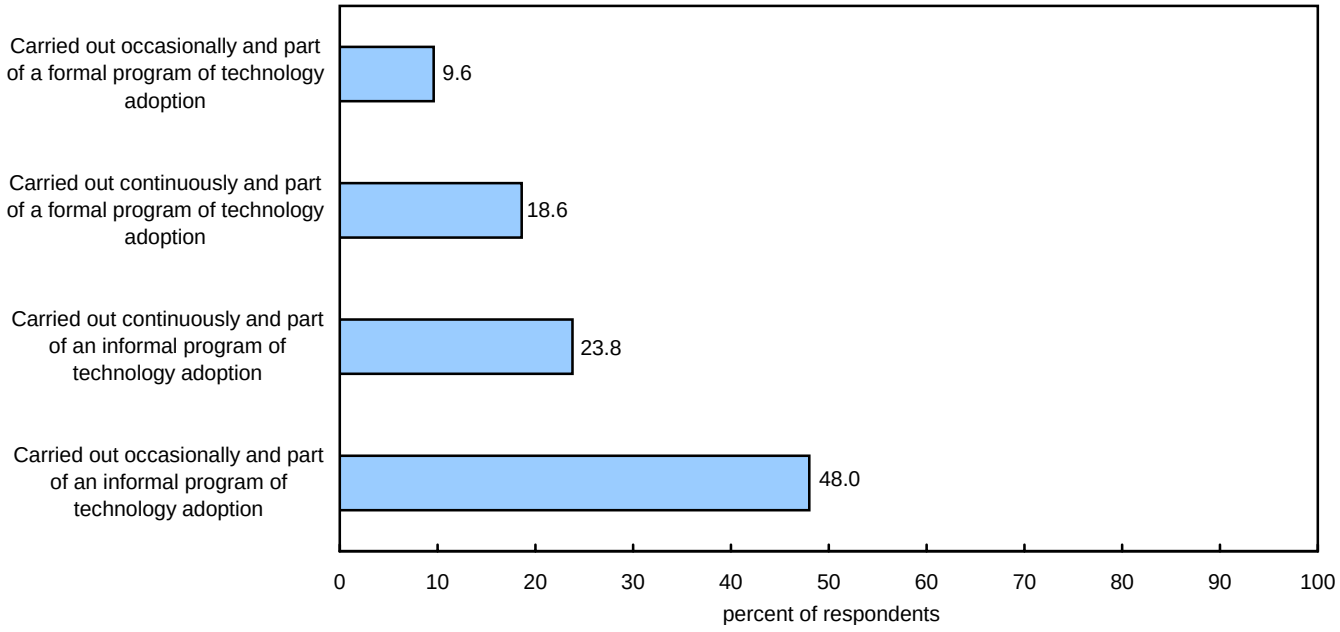
1. Estimates based on 1,218 responses resulting in a 99.9% response rate.
2. Estimates based on 1,212 responses resulting in a 99.5% response rate.

Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

Further, survey results show that almost half (48.0%) of user innovators indicated that they developed new technologies or modified an existing technology occasionally and as part of an informal program of technology adoption (Chart 2).

Chart 2

Percent of user innovator respondents indicating the frequency of development of new technologies or modification of existing technologies and the type of technology adoption program, formal or informal, under which development or modification of technologies is carried out in the plant[1]



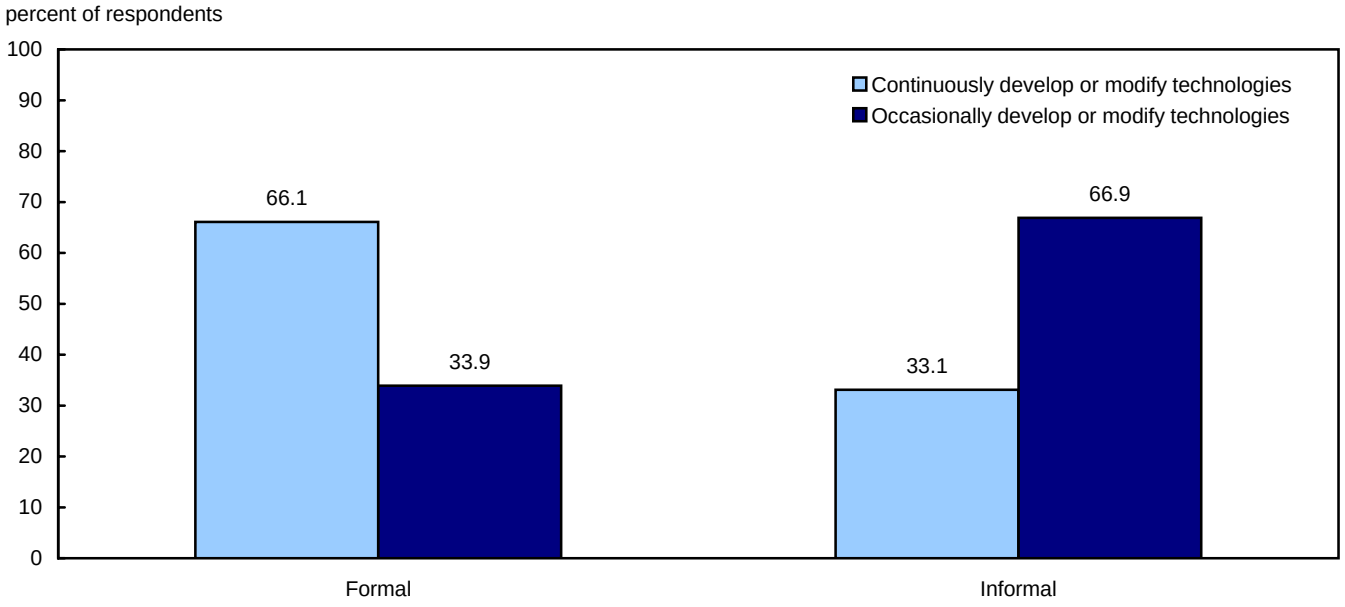
1. Estimates based on 1,212 responses resulting in a 99.4% response rate.

Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

User innovator respondents that indicated they carried out user innovation as part of a formal program of technology adoption were twice as likely to carry out these activities on a continuous rather than on an occasional basis (Chart 3). Similarly, user innovators that carried out technology modification activities as part of an informal program of technology adoption were twice as likely to carry out these activities occasionally rather than continuously. It would be interesting to explore whether the frequency of user innovation has an impact on innovation overall; whether plants that continuously carry out user innovation have more innovations than those that carry out user innovation occasionally. If so, this would emphasize the importance of formal programs of technology adoption for increasing innovation rates.

Chart 3

Percent of user innovator respondents indicating the frequency of development of new technologies or modification of existing technologies among plants with each type of technology adoption program under which technology development or modification is carried out in the plant[1]

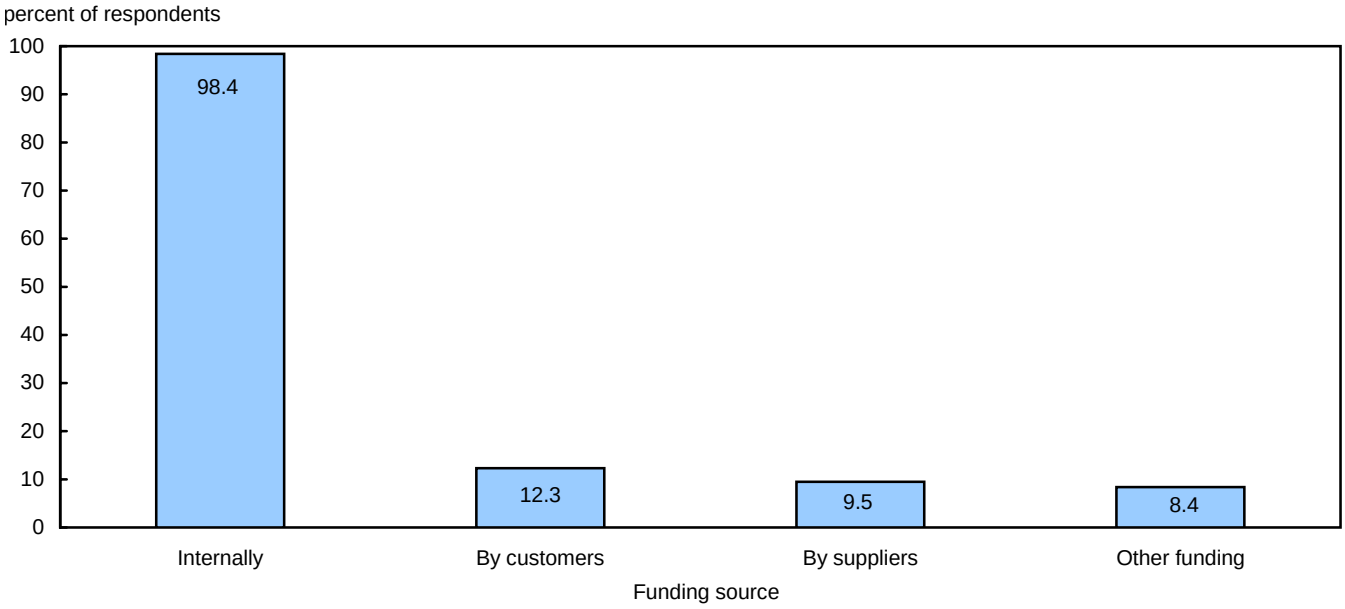


1. Estimates based on 1,212 responses resulting in a 99.4% response rate.
Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

The vast majority (98.4%) of user innovator respondents indicated they fund the development of new technologies or modification of existing technologies internally (Chart 4). Customers and suppliers were indicated as a source of funding for about one in ten user innovators each.

Chart 4

Percent of user innovator respondents indicating how development of new technologies or modification of existing technologies is funded in their plant[1]



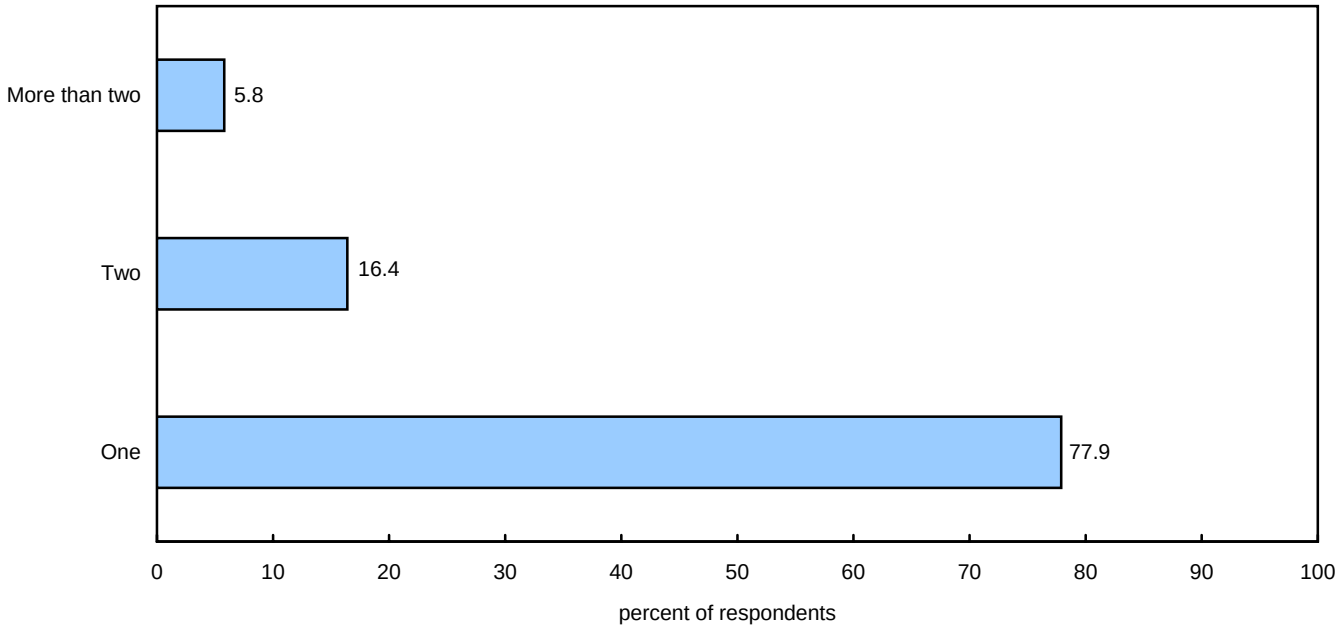
1. Estimates based on 1,215 responses resulting in a 99.7% response rate.

Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

The majority (77.9%) of user innovator respondents indicated one source of funding. Few (5.8%) had more than two (Chart 5).

Chart 5

Percent of respondents indicating number of sources of funding used for the development of new technologies or modification of existing technologies in the plant[1]



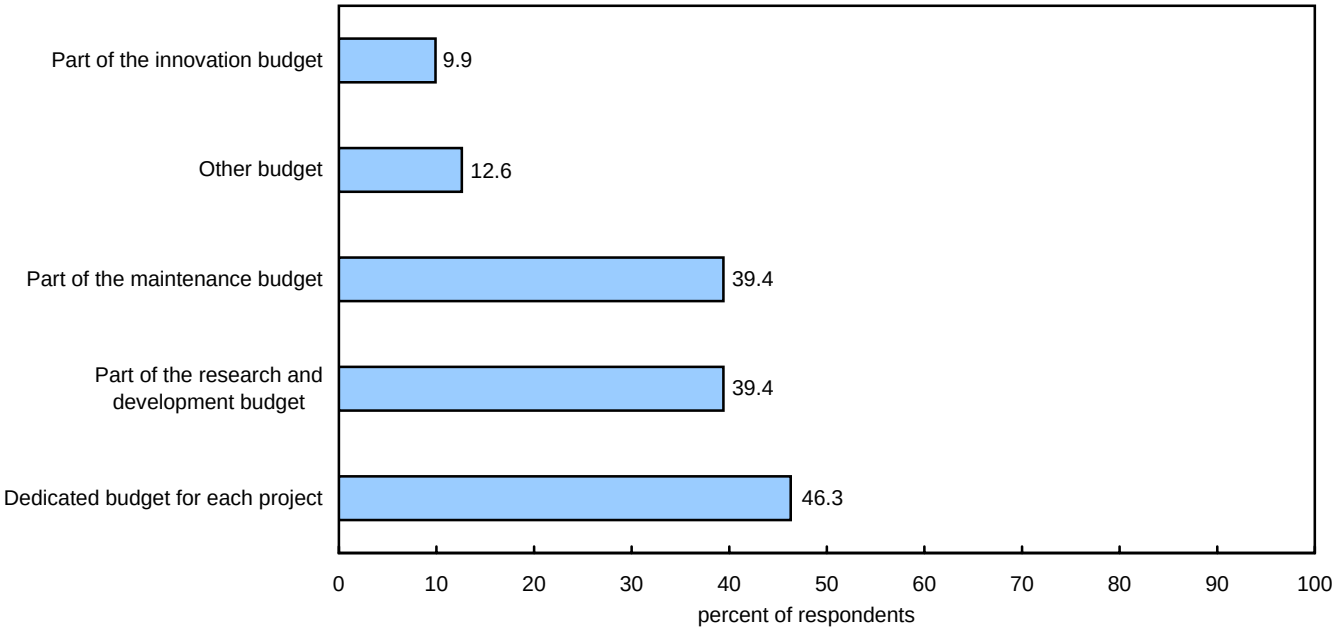
1. Estimates based on 1,215 responses resulting in a 99.7% response rate.
Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

Further, three quarters (76.4%) of user innovators indicated internal funding as the sole source of funding for their user innovation projects.

Almost half (46.3%) of responding user innovators indicated that they have a dedicated budget to fund the modification of technologies or development of new technologies (Chart 6). Responding user innovators were just as likely to fund the development of new technologies or modification of existing ones from their R&D budget as from the maintenance budget. Only one in ten plants (9.9%) responded that it was part of the innovation budget.

Chart 6

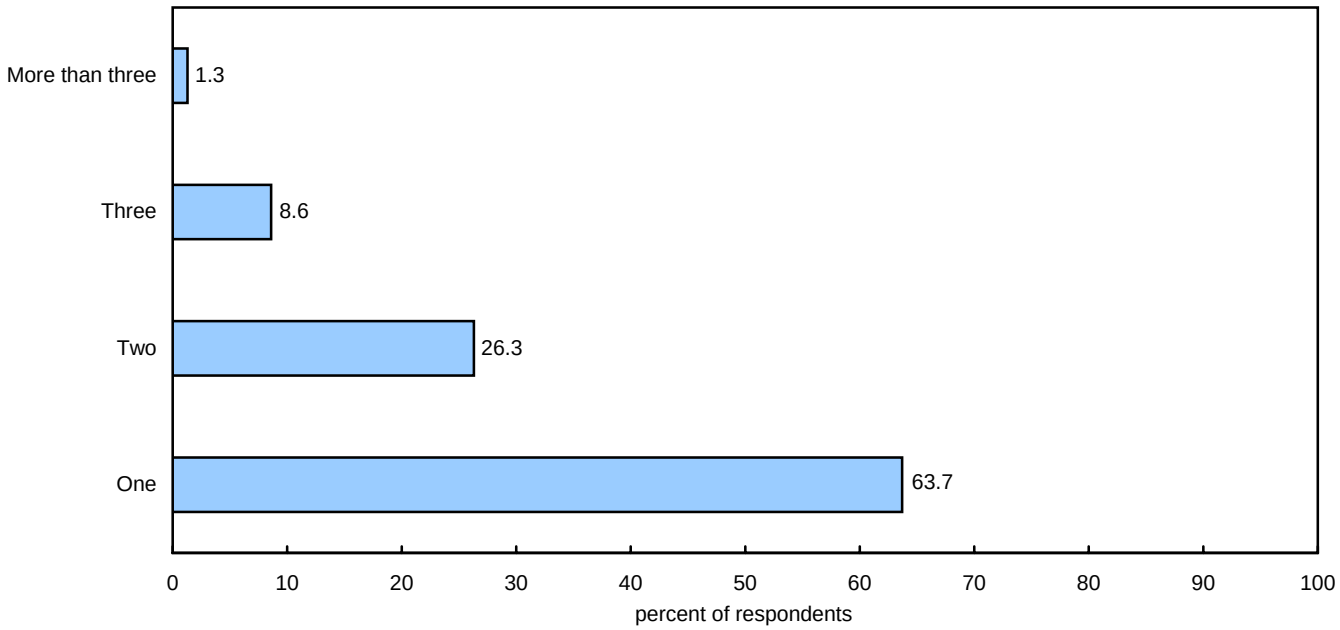
Percent of user innovator respondents indicating budget used to fund development of new technologies or modification of existing technologies in their plant[1]



1. Estimates based on 1,100 responses resulting in a 90.2% response rate.
Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

Almost two thirds (63.7%) of responding user innovators indicated they used only one budget to fund their user innovation projects (Chart 7). One in four (26.3%) used two.

Chart 7
Number of budgets used to fund the development of new technologies or modification of existing technologies[1]



1. Estimates based on 1,194 responses resulting in a 97.9% response rate.
Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

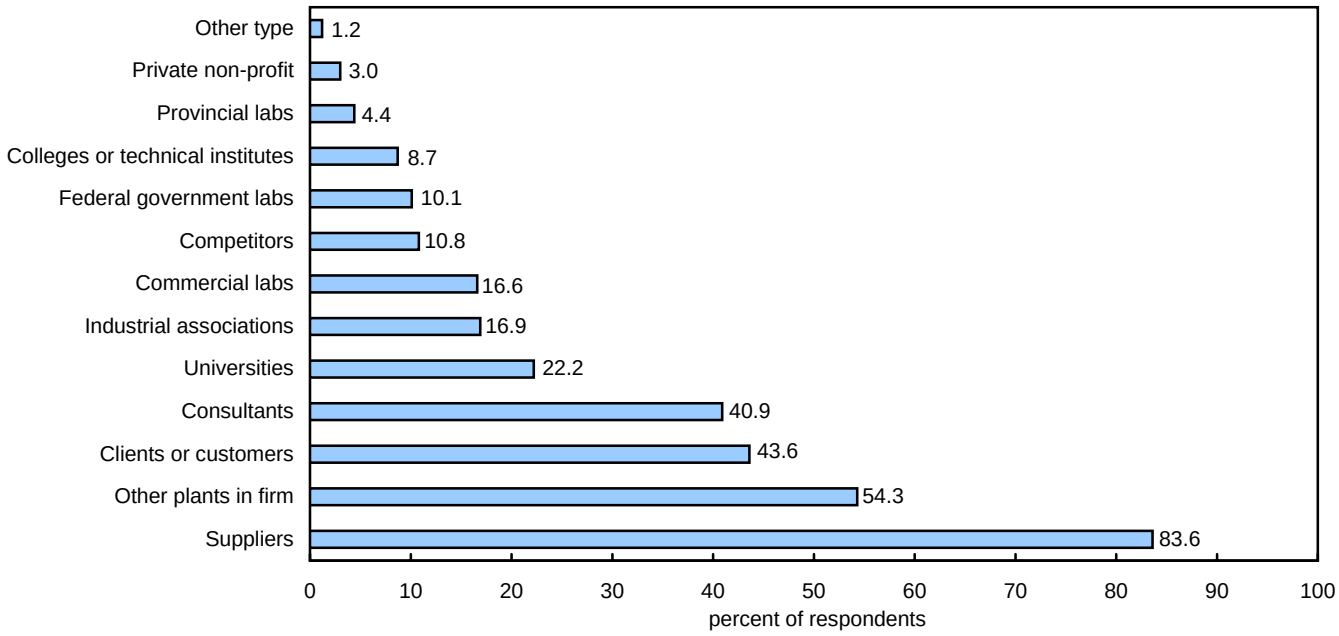
More than half of responding user innovators (58.9%) indicated that they did not know of any other firms that had developed similar new technologies to the ones they had developed or had carried out similar modifications. This suggests that most user innovators are producing novel innovations. Conversely, four in ten (41.1%) responding plants knew of other firms that had.

Cooperation is common among user innovators. Six out of ten (60.2%) user innovator respondents indicated they cooperated with other plants, firms or institutions to develop new technologies or modify existing technologies. Cooperation for user innovation is more prevalent than for innovation overall where two in ten (21.5%) innovative plants cooperated for innovation (Survey of Innovation 2005). Given that a proportion of user innovators are contributing to this, the contrast should be greater if the calculation for innovation overall did not include user innovators.

The most common type of cooperative partner for user innovators was suppliers (Chart 8). Half (54.3%) cooperated with other plants in the firm. About four in ten cooperated with clients or customers (43.6%) and consultants (40.9%). Almost one quarter (22.2%) of user innovators indicated they collaborated with universities.

Chart 8

Percent of user innovator respondents indicating that cooperated with other plants, firms or institutions for user innovation indicating who they cooperated with[1]



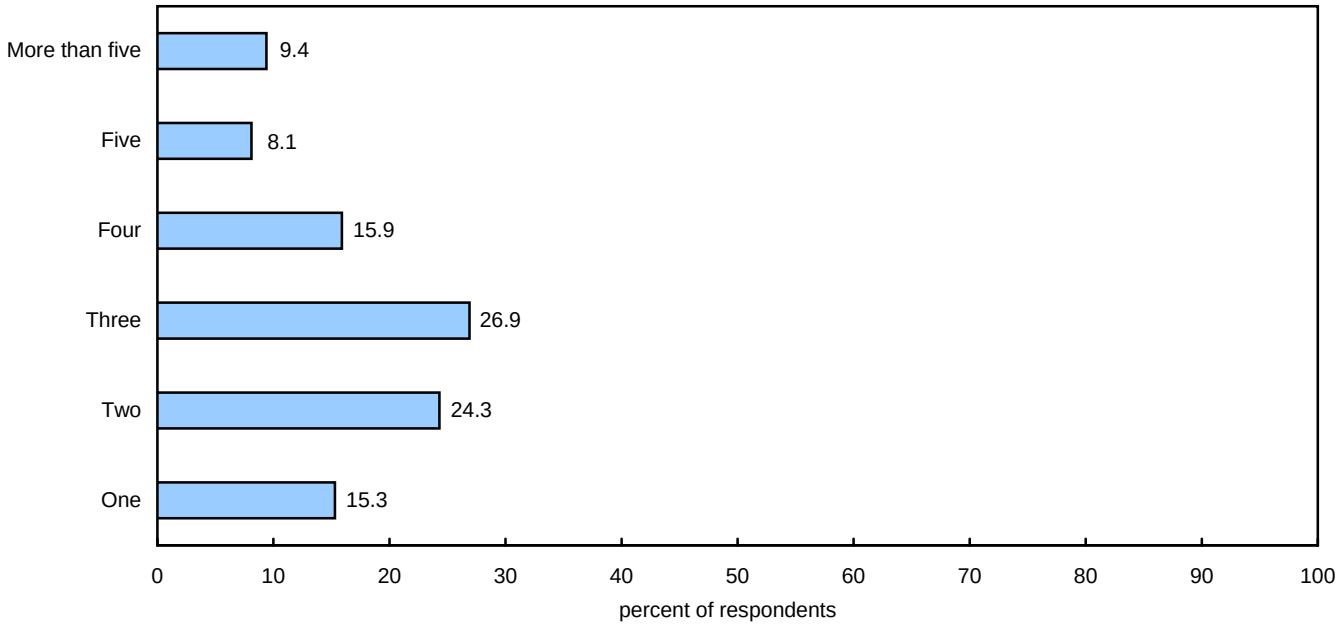
1. Estimates based on 724 responses resulting in a 98.8% response rate.

Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

Four out of five plants (82.5%) identified one to four types of cooperation partners (Chart 9). One quarter (24.3%) identified two partners and one quarter (26.9%), three partners.

Chart 9

Percent of user innovator respondents that cooperated for the development of new technologies or modification of existing technologies in their plant with number of cooperation partners[1]

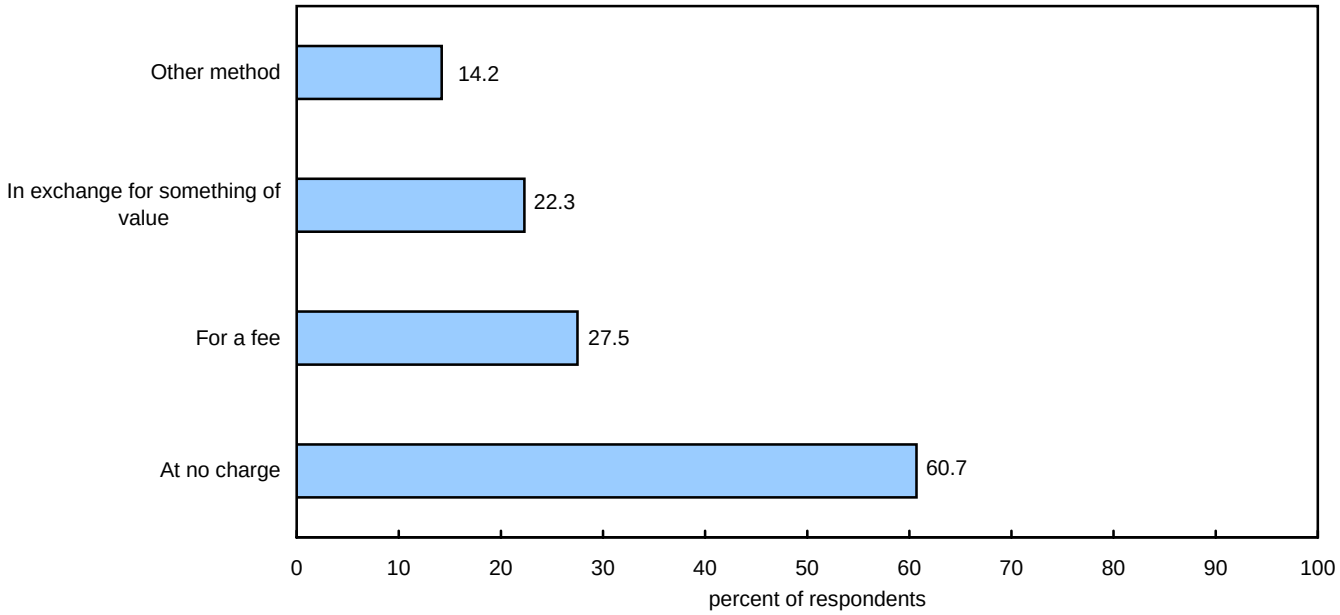


1. Estimates based on 724 responses resulting in a 98.8% response rate.
Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

User innovations are being diffused. About one in five (18.0%) user innovators that responded indicated that they shared their new technologies or technology modifications with other firms or institutions (Chart 10). When plants did share, six out of ten (60.7%) responding firms indicated they did so at no charge.

Chart 10

Percent of user innovator respondents who shared the new technologies they developed or technologies they modified with other firms or institutions indicating how they shared[1]



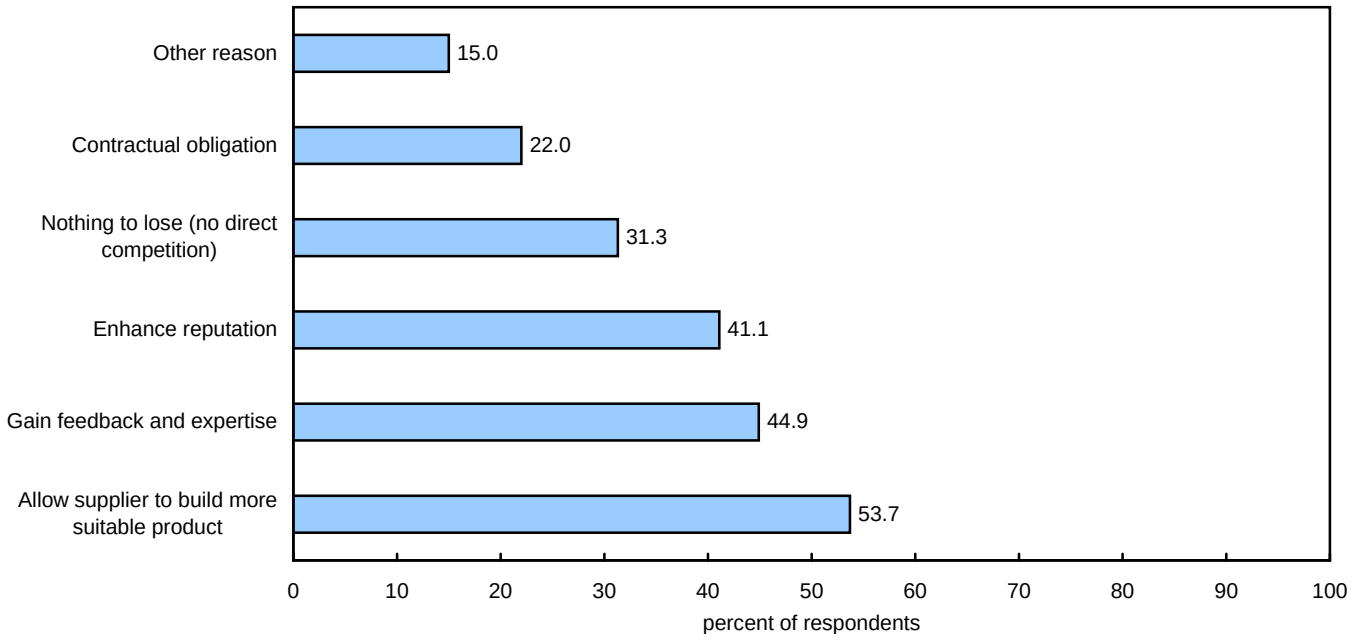
1. Estimates based on 211 responses resulting in a 96.3% response rate.

Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

More than half (53.7%) of the user innovators who shared their user innovations indicated they chose to share to allow a supplier to build a more suitable final product. These linkages between plants promote the diffusion of innovations and are an important component of innovation overall. Clearly these firms are part of the innovation process by contributing ideas. However it is not known whether the supplier would recognize or acknowledge these firms as a source of information for innovation when responding to more traditional innovation survey questionnaires. User innovators see benefit from sharing their innovations. Enhancing reputation and gaining expertise were indicated as reasons for sharing by at least four of ten plants that shared (Chart 11). Contractual obligation was a motivator for only about one quarter (22.0%) of user innovative plants. Almost one third (31.3%) indicated they have nothing to lose from sharing.

Chart 11

Percent of user innovator respondents that shared the new technologies they developed or technologies they modified with other firms or institutions indicating the reasons why they chose to share[1]



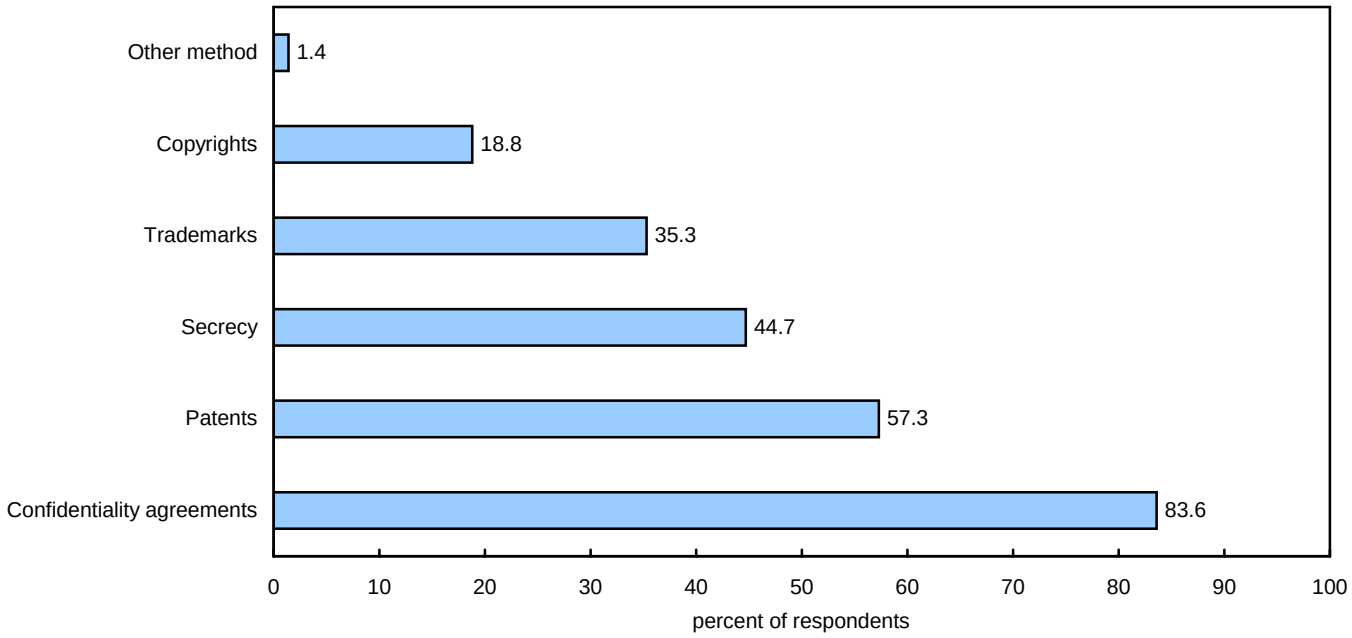
1. Estimates based on 214 responses resulting in a 97.7% response rate.

Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

More than half (53.3%) of the user innovators who responded indicated that they use some method to protect the intellectual property resulting from the modification of technologies. This contrasts to the recent findings of von Hippel and de Jong (2008) who find that only 9% of all user innovations in manufacturing SMEs (less than 100 employees) are protected and suggests that plant size should be considered in the analysis. Confidentiality agreements were used by most user innovators to protect their intellectual property (Chart 12). Patents were used by more than half (57.3%) of user innovator respondents who protected their intellectual property.

Chart 12

Percent of user innovator respondents that used methods to protect the intellectual property (IP) resulting from the new technologies they developed or technologies they modified indicating methods used[1] to protect the intellectual property



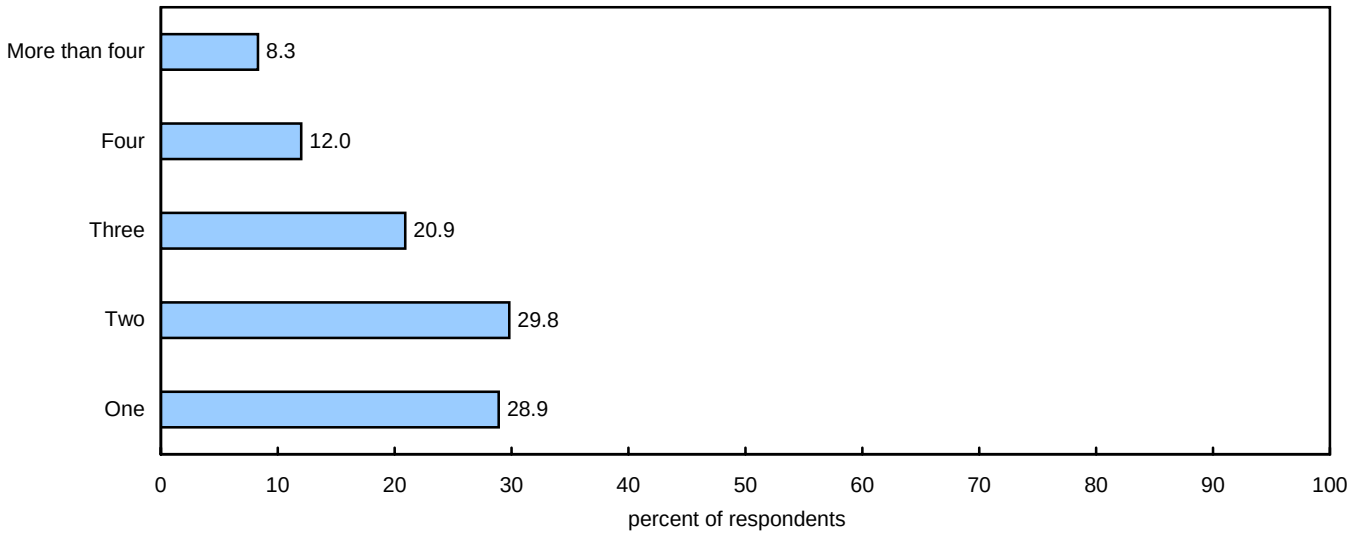
1. Estimates based on 640 responses resulting in a 98.6% response rate.
Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

There is debate over the impact of intellectual property protection on fostering innovation. Two thirds (66.7%) of user innovators who shared their user innovations used some method to protect their intellectual property. However, among user innovators that did not share, half (50.3%) still used some method to protect their intellectual property. This suggests that plants that use intellectual property protection are more likely to share their user innovations than those that do not protect their intellectual property and warrants further investigation. What is not known is whether the user innovation that was shared was protected.

More than half of user innovators used one or two methods to protect the intellectual property resulting for the modification of technologies or development of new technologies (Chart 13). One in five (20.9%) used three methods.

Chart 13

Number of methods used to protect intellectual property by user innovators that protect the intellectual property of their user innovations[1]

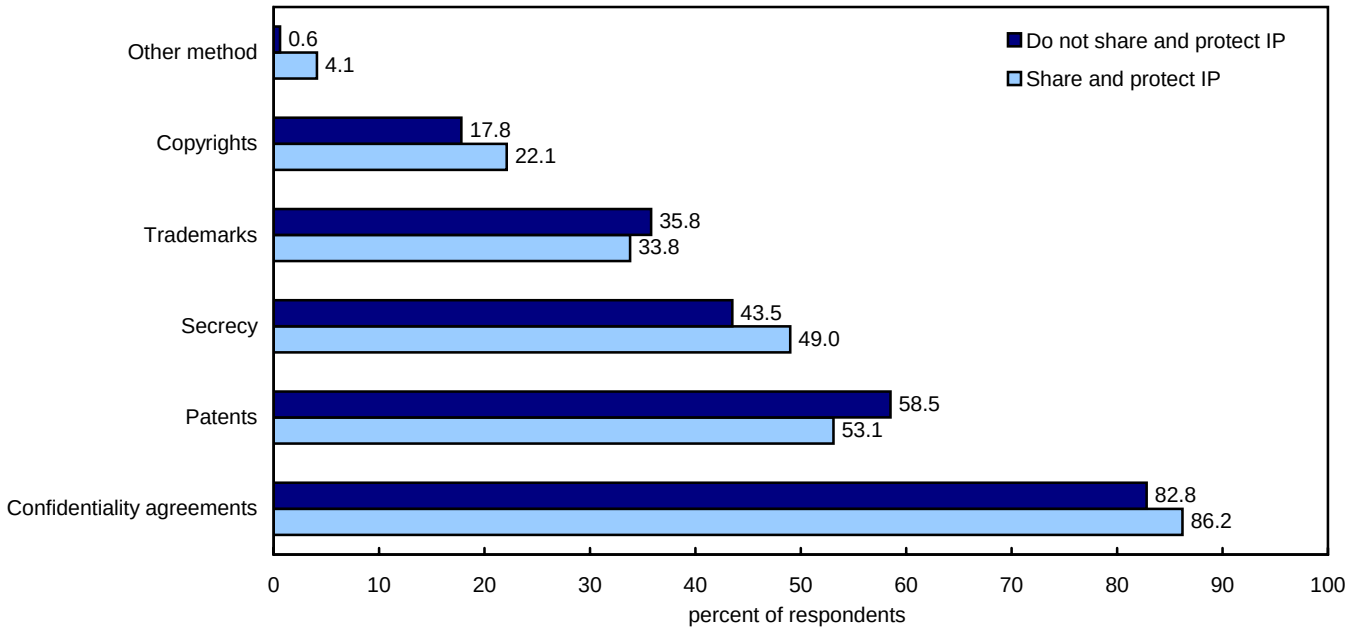


1. Estimates based on 640 responses resulting in a 98.6% response rate.
Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

There are no large differences in the methods used to protect intellectual property by plants that share and those that do not share their user innovations (Chart 14). Whether or not user innovations are shared does not seem to influence how the intellectual property of these user innovations is protected. A statistical sample would permit the construction of confidence intervals and it could be determined if estimates were statistically significantly different from one another.

Chart 14

Percent of user innovator respondents using methods to protect the intellectual property (IP) resulting from the new technologies they developed or technologies they modified for plants that protect their intellectual property by whether they share[1] or do not share[2] their user innovations with other firms or institutions



1. Estimates based on 145 responses resulting in a 99.3% response rate.
2. Estimates based on 494 responses resulting in a 98.4% response rate.

Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

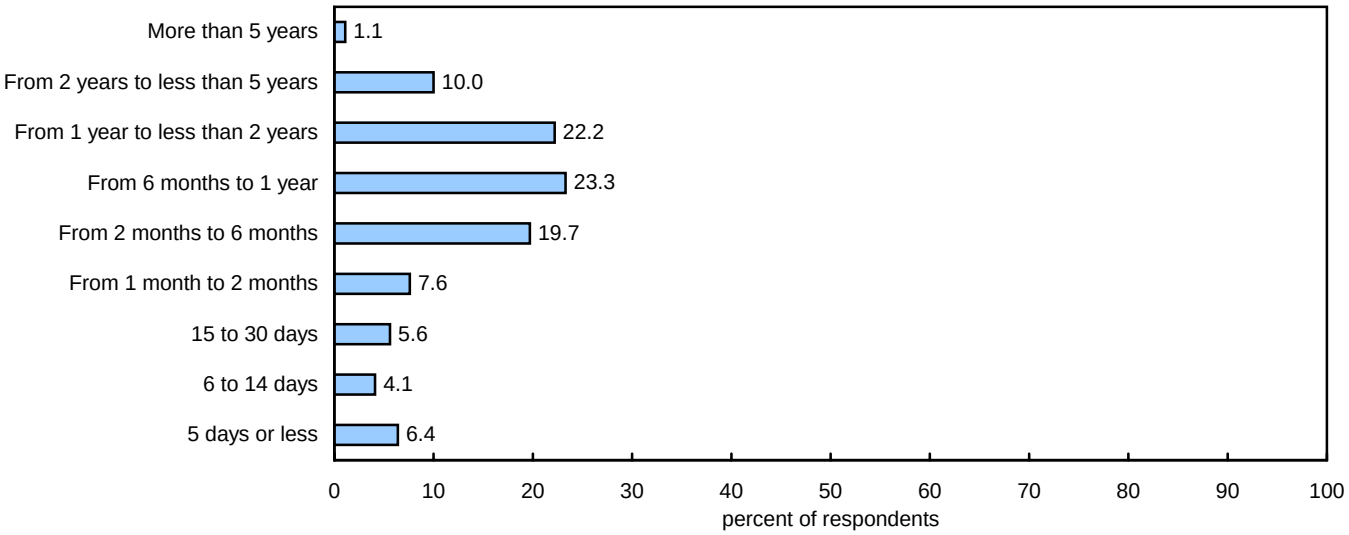
User innovations are being diffused making user innovators part of the innovation process. One quarter (26.3%) of user innovator respondents indicated that the new technologies (or parts of them) developed by their plant were adopted by another manufacturing firm to produce and supply the new technology or that the modifications were adopted by the supplier of the original technology. These suppliers may be producing and supplying these product innovations to other users. It is not clear whether this would be indicated as a process innovation by the user innovator and a product innovation by the original supplier or both. However it is clear that user innovators are part of the innovation process. In addition, one quarter (25.3%) of user innovation respondents indicated that the new technologies they developed were adopted by other firms to use the new technology or that their modifications were adopted by other firms that use the original technology.

In order to facilitate response to questions on cost of new technology development or modification of technologies, respondents were directed to respond in reference to their most recently developed new technology or most recently modified technology. The average estimated total cost of labour for the most recent user innovation was $326,177 with a median value of $45,000. The average estimated total cost of machinery, equipment and/or materials required for the most recent user innovation was $484,595 with a median value of $50,000. Considering labour cost and cost of machinery, equipment and materials together, the average total cost of the most recent user innovation was $815,580 with a median value of $125,000. It should be noted that during cognitive testing of the questionnaire, some respondents found it easier to recall a larger project rather than the most recent. This introduces some degree up upward bias in the cost estimates with a few very large projects skewing the average costs and can help to explain why the average costs are about ten times larger than the median costs.

Two thirds (65.2%) of user innovators that responded indicated that it took from 2 months to less than two years to complete the development of their most recently developed new technology or modification of their most recently modified technology (Chart 15).

Chart 15

Percent of user innovator respondents indicating estimated elapsed time required to complete their most recently developed new technology or most recently modified existing technology[1]



1. Estimates based on 1,144 responses resulting in a 93.8% response rate.
Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

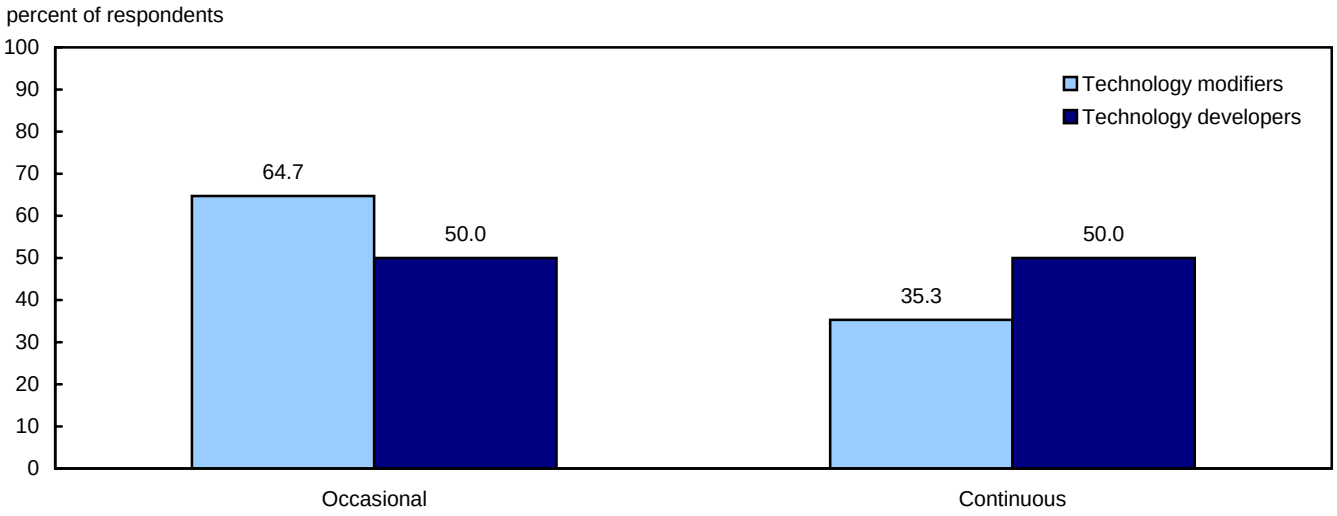
2.4 Activities of technology modifiers and technology developers

Response rates by question for technology modifiers and technology developers differ by no more than 5.7% (Appendix A, Table A). Given comparable response rates and response rates of at least 84% for all questions, response bias is not considered an issue and characteristics of technology modifiers can be compared to technology developers.

Responses provided by technology modifiers indicate that they are most likely to carry out technology modification on an occasional basis, whereas technology developers have an equal likelihood of carrying out user innovation occasionally or continuously (Chart 16). Technology modifiers are more likely than technology developers to carry out user innovation on an occasional basis. Conversely, technology developers are more likely than technology modifiers to carry out user innovation continuously.

Chart 16

Percent of technology developer respondents and technology modifier respondents indicating the frequency of development of new technologies or modification of technologies in their plant[1]



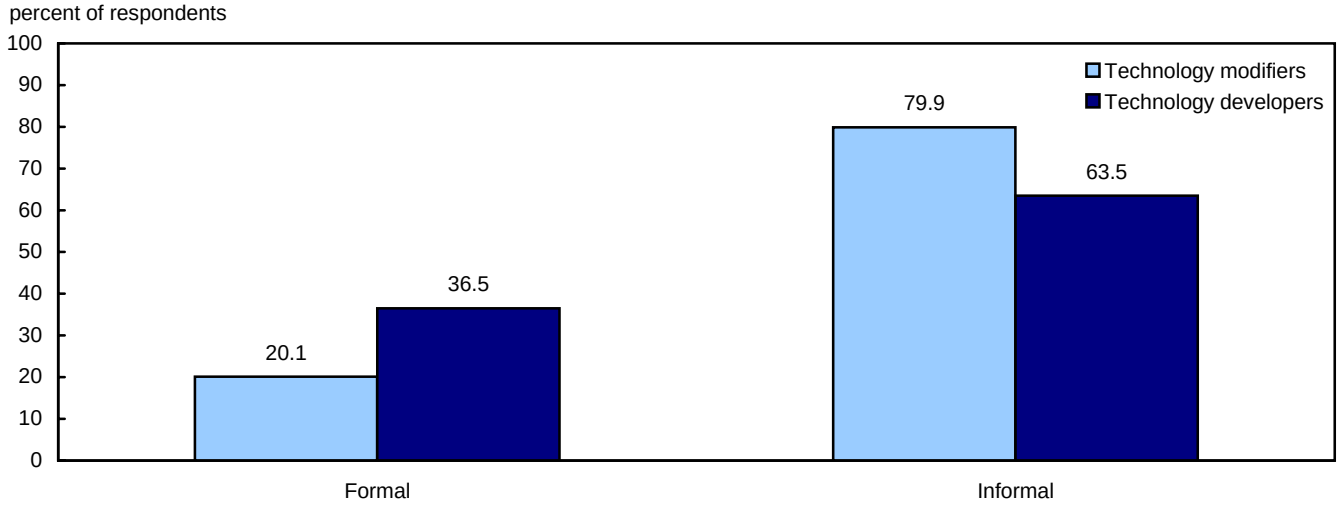
1. Estimates based on 618 responses of technology modifiers resulting in a 100.0% response rate and 600 responses of technology developers resulting in a 99.8% response rate.

Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

Technology modifiers and technology developers are most likely to carry out user innovation as part of an informal program of technology adoption (Chart 17). Technology modifiers are four times more likely to carry out technology modification as part of an informal rather than as part of a formal program of technology adoption. Technology developers are more than one and a half times as likely to develop new technologies as part of an informal program as opposed to a formal program of technology adoption. When technology developers are compared to technology modifiers, technology developers are much more likely than modifiers to have a formal program whereas technology modifiers are more likely than developers to have an informal program of technology adoption.

Chart 17

Percent of technology developer respondents and technology modifier respondents indicating the type of technology adoption program under which new technologies are developed or technologies are modified in their plant[1]



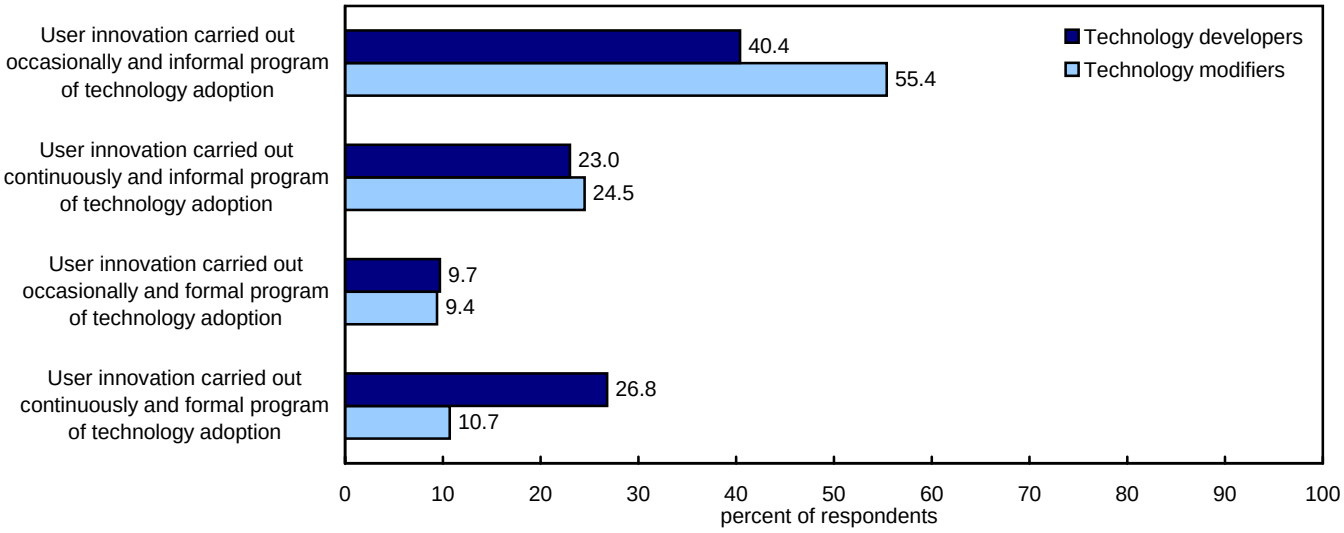
1. Estimates based on 616 responses of technology modifiers resulting in a 99.7% response rate and 597 responses of technology developers resulting in a 99.3% response rate.

Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

Both technology modifiers and technology developers are most likely to carry out user innovation occasionally and as part of an informal program of technology adoption (Chart 18). Technology modifiers and technology developers have the same likelihood of carrying out user innovation continuously and having an informal program of technology adoption. They also have the same likelihood of carrying out user innovation occasionally and having a formal program of technology adoption. Technology developers distinguish themselves from technology modifiers in that they are more than twice as likely to carry out user innovation continuously and to have a formal program of technology adoption. Technology modifiers, on the other hand, are more likely than technology developers to carry out user innovation occasionally and have an informal program of technology adoption.

Chart 18

Percent of technology developer[1] and technology modifier[2] respondents indicating the type of technology adoption program, formal or informal, and the frequency of development of new technologies or modification of existing technologies in their plant



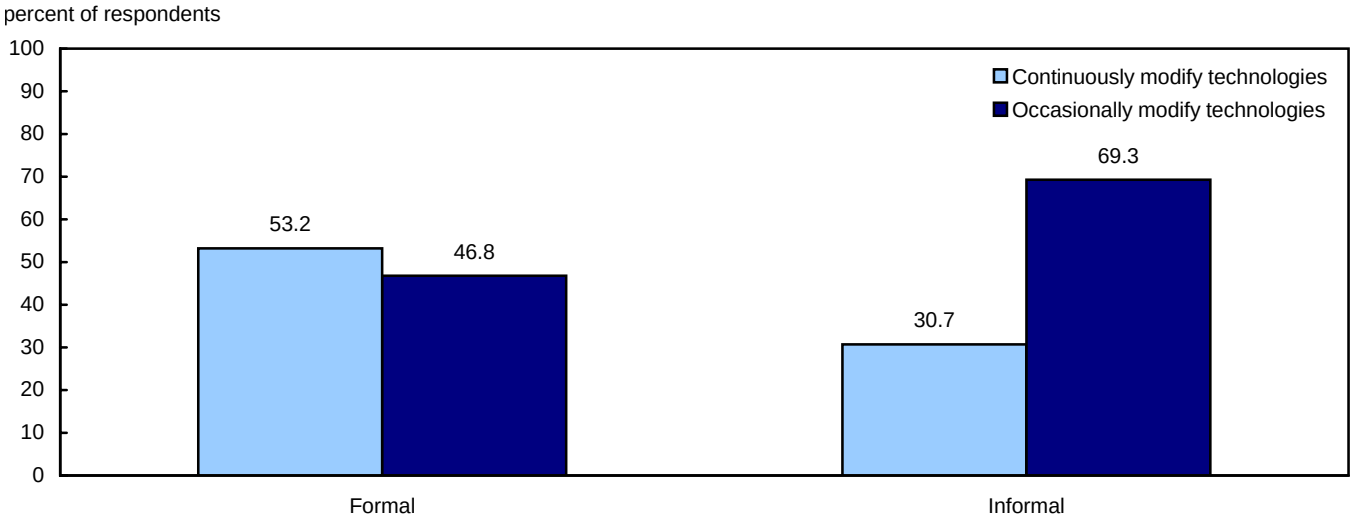
1. Estimates based on 596 responses resulting in a 99.2% response rate.
2. Estimates based on 616 responses resulting in a 99.7% response rate.

Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

Responses from technology modifiers and developers suggests that plants with formal programs of technology adoption carry out user innovation more frequently (i.e. continuously) than those with informal programs. Among technology modifier respondents that carried out technology modification activities as part of an informal program of technology adoption, modification was more than twice as likely to be carried out occasionally. Among technology modifier respondents that carried out technology modifications as part of a formal program of technology adoption there was a slightly greater likelihood of carrying out these activities on a continuous as opposed to an occasional basis (Chart 19).

Chart 19

Percent of technology modifier respondents indicating the frequency of modification of technologies among plants with each type of technology adoption program under which modification of technologies is carried out in their plant[1]

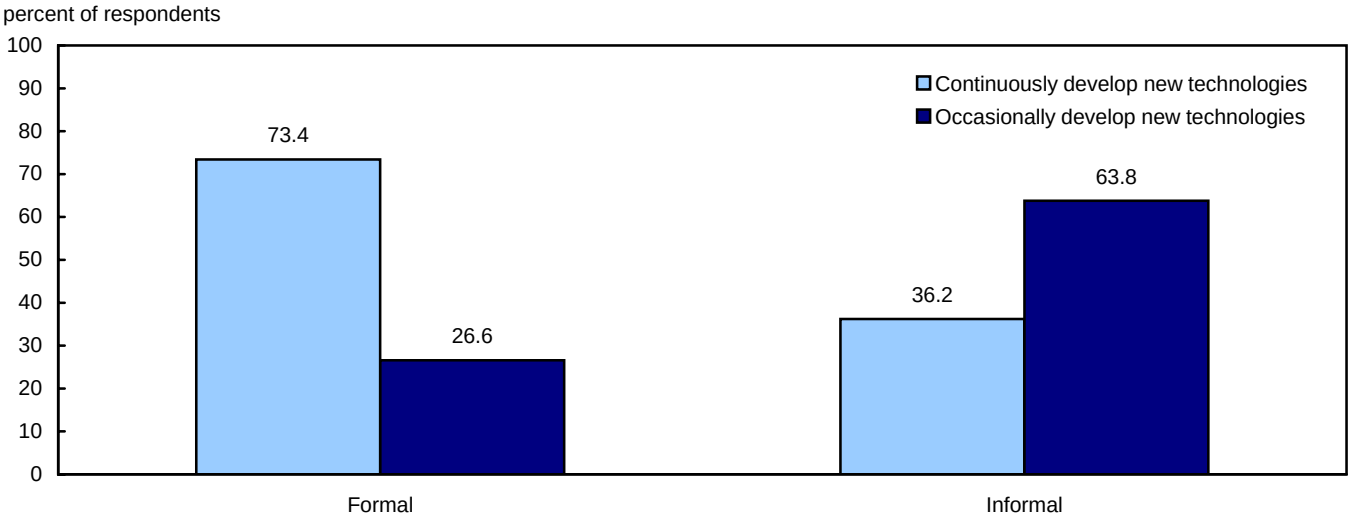


1. Estimates based on 616 responses resulting in a 99.7% response rate.
Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

These contrasts are even sharper for technology developers (Chart 20). Among technology developers that developed new technologies as part of a formal program of technology adoption, plants were more than two and half times more likely to continuously develop new technologies and those that developed new technologies as part of an informal program of technology adoption were more than one and a half times as likely to occasionally develop new technologies. This suggests that having a formal program of technology adoption promotes continuous innovation.

Chart 20

Percent of technology developer respondents indicating the frequency of development of new technologies for each type of technology adoption program, formal or informal, under which development of new technologies is carried out in their plant[1]



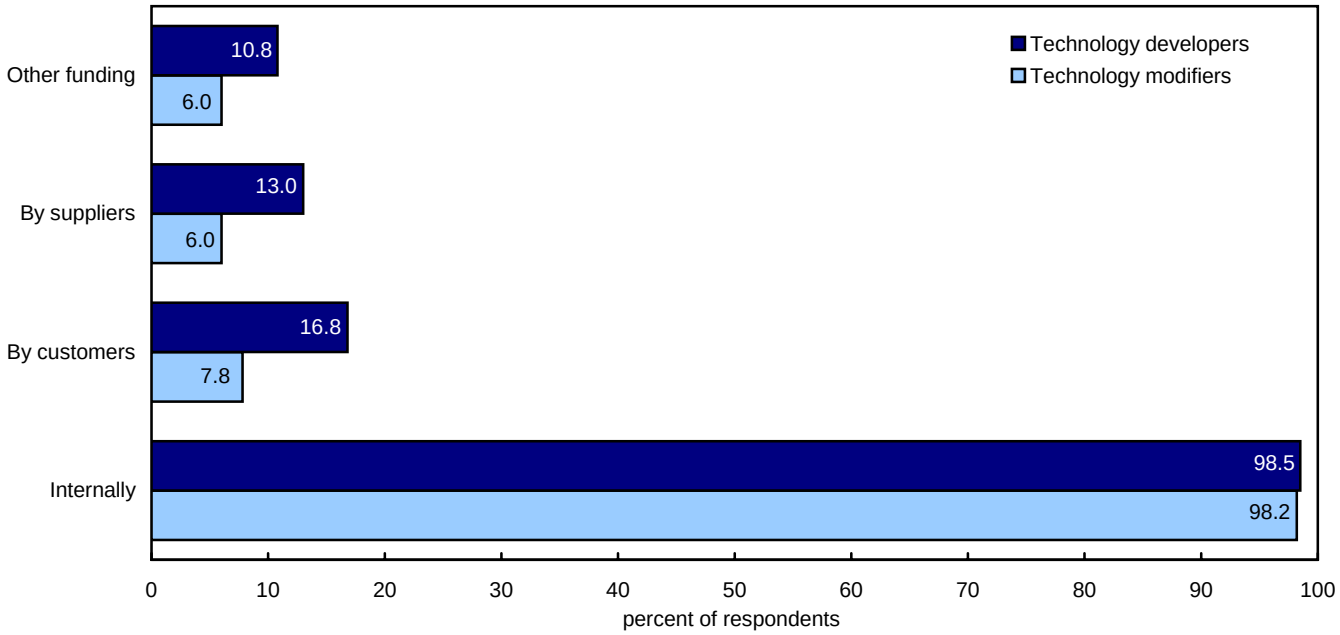
1. Estimates based on 596 responses resulting in a 99.2% response rate.

Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

Almost all technology modifiers and technology developers indicated that they funded their modification or development of technologies internally (Chart 21). Customers followed closely by suppliers were the next most commonly indicated sources of funding for both technology modifiers and technology developers. However, technology developers are more than twice as likely as modifiers to have these sources of funding, highlighting that technology developers are more likely than technology modifiers to have external sources of funding for their user innovation projects. Customers are a source of funding for one in six (16.8%) technology developers. This linkage between actors in the innovation system is something that should be explored further.

Chart 21

Percent of technology developer and technology modifier respondents indicating how development of new technologies or modification of technologies is funded in their plant[1]

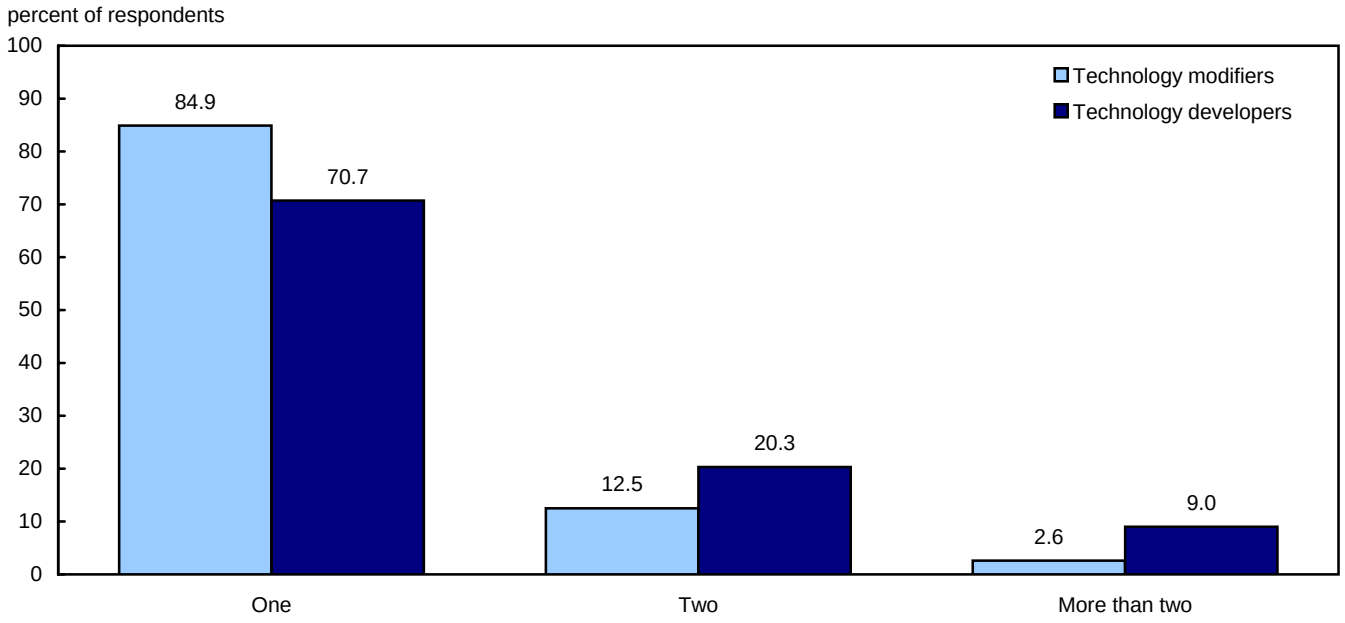


1. Estimates based on 615 responses of technology modifiers resulting in a 99.5% response rate and 600 responses of technology developers resulting in a 99.8% response rate.

Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

Although most likely to have only one source of funding for their user innovation projects, technology developers are twice as likely as technology modifiers to have more than one source of funding (Chart 22). Three in ten (29.3%) technology developers had multiple funding sources compared to fewer than two in ten (15.1%) technology modifiers. Technology modifiers (84.9%) are more likely to have only one source of funding than technology developers (70.7%). Technology developers (20.3%) are almost twice as likely as technology modifiers (12.5%) to have two sources of funding.

Chart 22
Number of sources of funding in the plant for development of new technologies or modification of technologies for technology developer and technology modifier respondents[1]



1. Estimates based on 615 responses of technology modifiers resulting in a 99.5% response rate and 600 responses of technology developers resulting in a 99.8% response rate.

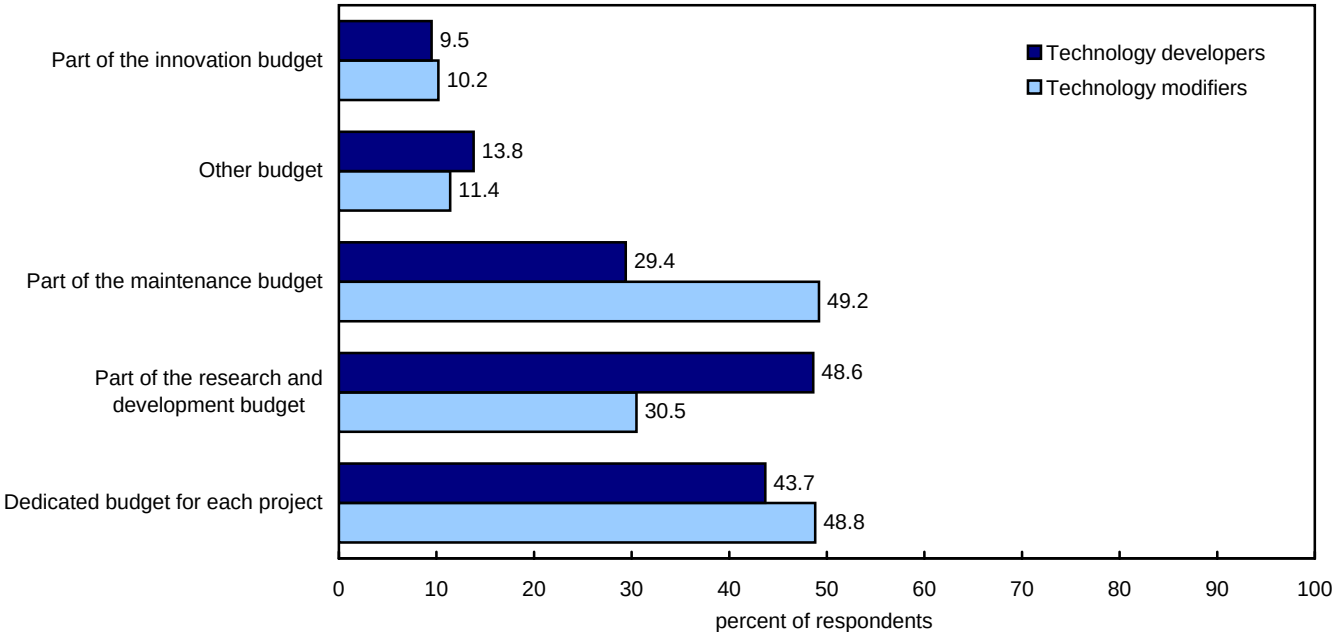
Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

Technology modifiers are more likely than technology developers to exclusively fund user innovation internally. Almost seven in ten (69.3%) technology developers indicated only internal funding for their user innovation compared to more than eight in ten technology modifiers (83.3%). This suggests that technology developers have more linkages in the innovation system than technology modifiers.

Technology developers are most likely to fund the development of new technologies as part of the R&D budget (48.6%) followed closely by having a dedicated budget for each project (43.7%) (Chart 23). Technology modifiers, on the other hand, are just as likely to have a dedicated budget for each project (48.8%) as they are to fund the modification of technology as part of the maintenance budget (49.2%). Three in ten (30.5%) technology modifiers indicated they funded technology modification from their R&D budget. Only one in ten technology modifiers (10.2%) and one in ten technology developers (9.5%) responded that they funded their user innovations through an innovation budget. It is interesting to note that only about half of the technology modifier and technology developer respondents indicated that they had a dedicated budget for each modification or development project or program. This is not unusual considering that user innovation projects are most likely to be carried out occasionally and as part of an informal program of technology adoption for both technology developers and modifiers in which case a dedicated budget would not be expected.

Chart 23

Percent of technology developer and technology modifier respondents indicating the budget used to fund the development of new technologies or modification of technologies in their plant[1]

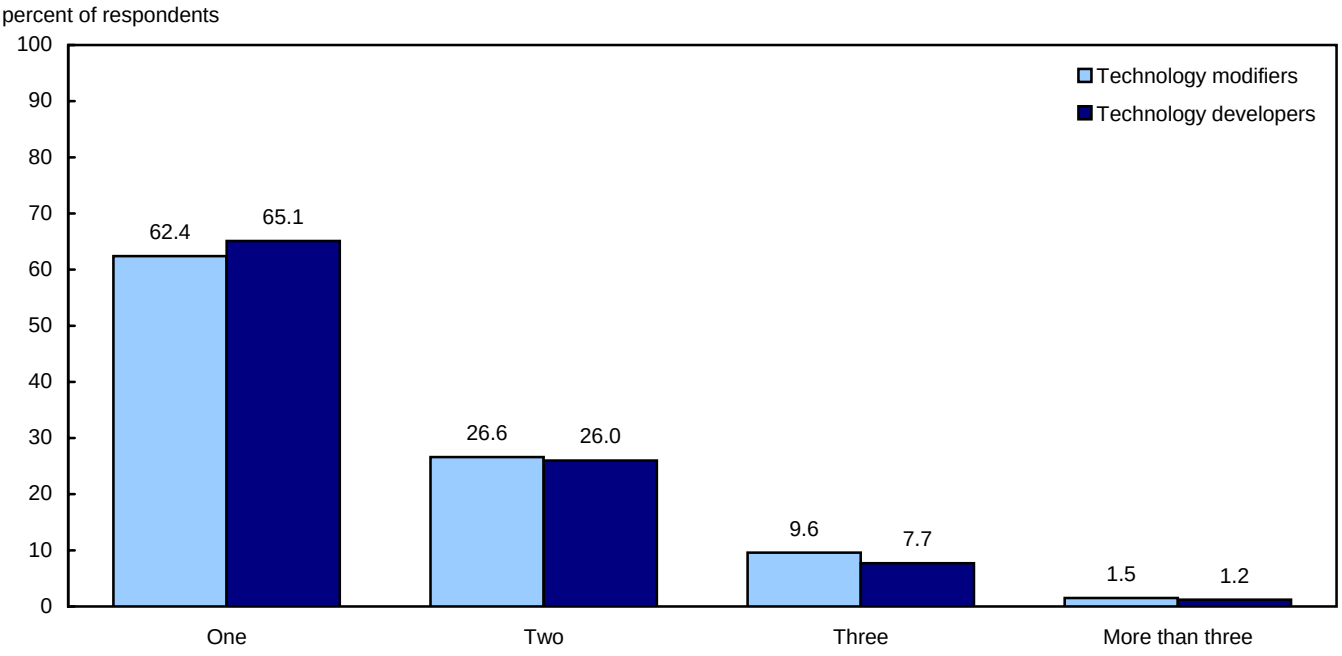


1. Estimates based on 606 responses of technology modifiers resulting in a 98.1% response rate and 588 responses of technology developers resulting in a 97.8% response rate.

Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

Both technology modifiers and technology developers are most likely to use only one budget for their user innovation projects (Chart 24). Responses indicate that technology modifiers and developers have similar behaviour for the number of budgets used.

Chart 24
Number of budgets used to fund the development of new technologies or modification of technologies for technology developer and technology modifier respondents[1]



1. Estimates based on 606 responses of technology modifiers resulting in a 98.1% response rate and 588 responses of technology developers resulting in a 97.8% response rate.

Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

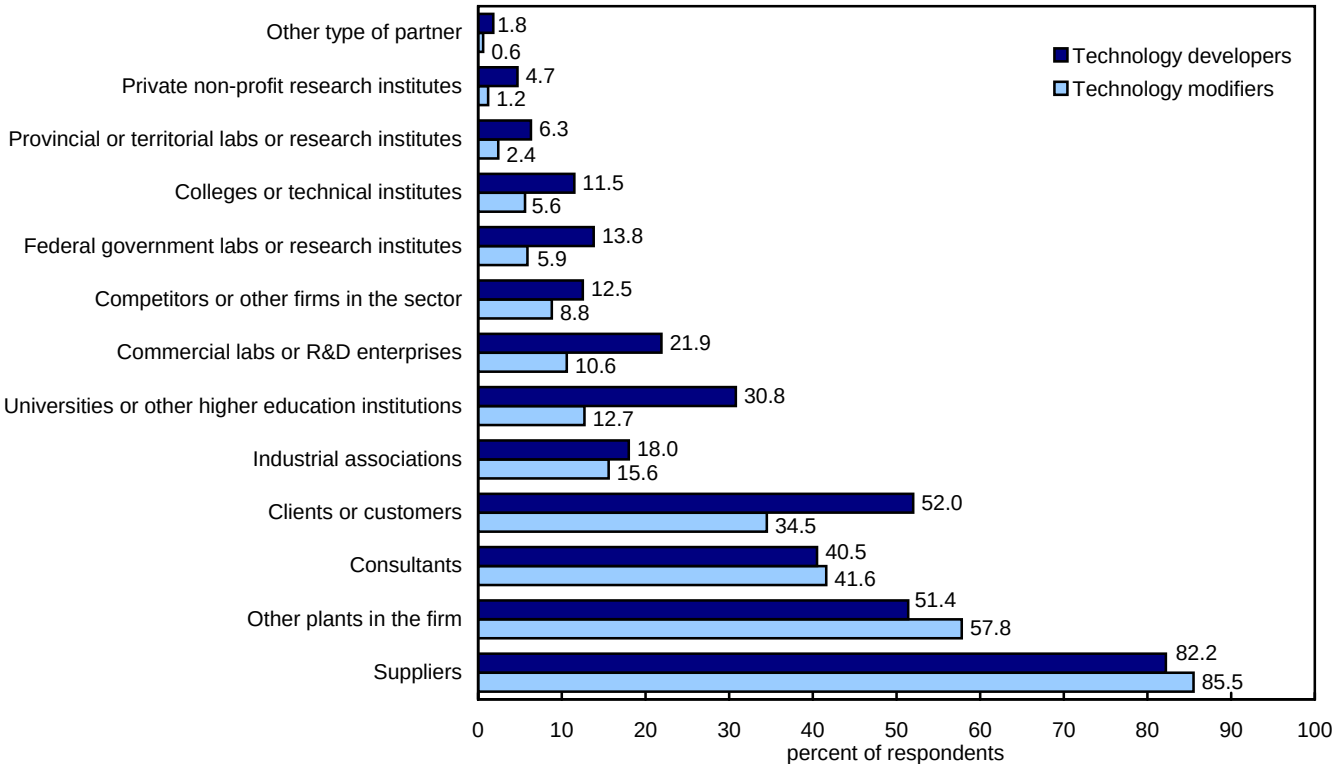
The majority of both technology modifiers (62.0%) and technology developers (55.8%) indicated that they did not know of any other firms that had created similar user innovations. It would be interesting to examine how these respondents would report the novelty (world, country or plant first) of their innovations. A high incidence of world or country-first innovation novelty would be expected amongst each type of user innovator.

Although a common activity for both technology modifiers and technology developers, cooperation on user innovation projects is more likely among technology developers. More than half (55.5%) of responding technology modifiers indicated they cooperated with other plants, firms or institutions to modify existing technologies compared to almost two thirds (65.1%) of technology developers that cooperated to develop new technologies. The linkages created through cooperation characterize technology developers as having a higher propensity to be linked than technology modifiers.

More than four out of five technology developers and modifiers that responded they co-operated on their user innovation projects indicated they cooperated with suppliers, making them the most likely partner for both types of plants (Chart 25). Technology developers are next most likely to cooperate with clients or other business units in the firm, followed by consultants. Technology modifiers are next most likely to cooperate with other business units in the firm, followed by clients and then consultants. Technology developers are more likely than technology modifiers to cooperate with clients or customers, commercial labs, universities, colleges, and federal government labs whereas technology modifiers are more likely than developers to cooperate with other plants in the firm.

Chart 25

Cooperation partners for technology developer and technology modifier respondents that indicated they cooperated with other plants, firms or institutions to develop new technologies or modify technologies[1]



1. Estimates based on 339 responses of technology modifiers resulting in a 98.8% response rate and 383 responses of technology developers resulting in a 98.2% response rate.

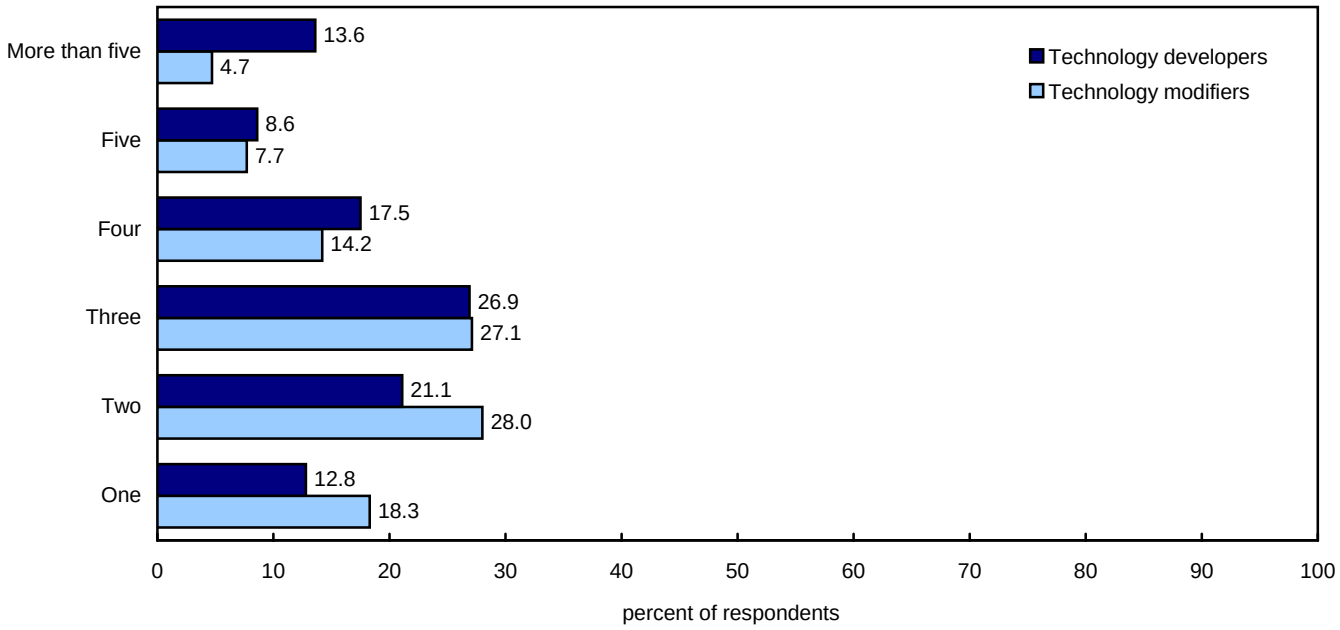
Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

There is less than 5% difference between the percentage of technology modifiers and developers cooperating with industrial associations, private non-profit research institutes, provincial or territorial labs or research institutes, consultants, competitors, and suppliers. As a result, there is no greater likelihood that a technology developer or modifier will choose one of these partners.

Among user innovators that cooperate, technology developers are likely to have a larger number of types of cooperation partners than technology modifiers (Chart 26). Technology modifiers are more likely than developers to have one or two types of partners whereas technology developers are more likely than modifiers to have four or more types of partners. Both are just as likely to have three.

Chart 26

Number of types of cooperation partners for technology modifier and technology developer respondents that cooperated with other plants, firms or institutions for the modification of existing technologies or development of new technologies in their plant[1]



1. Estimates based on 339 responses of technology modifiers resulting in a 98.8% response rate and 383 responses of technology developers resulting in a 98.2% response rate.

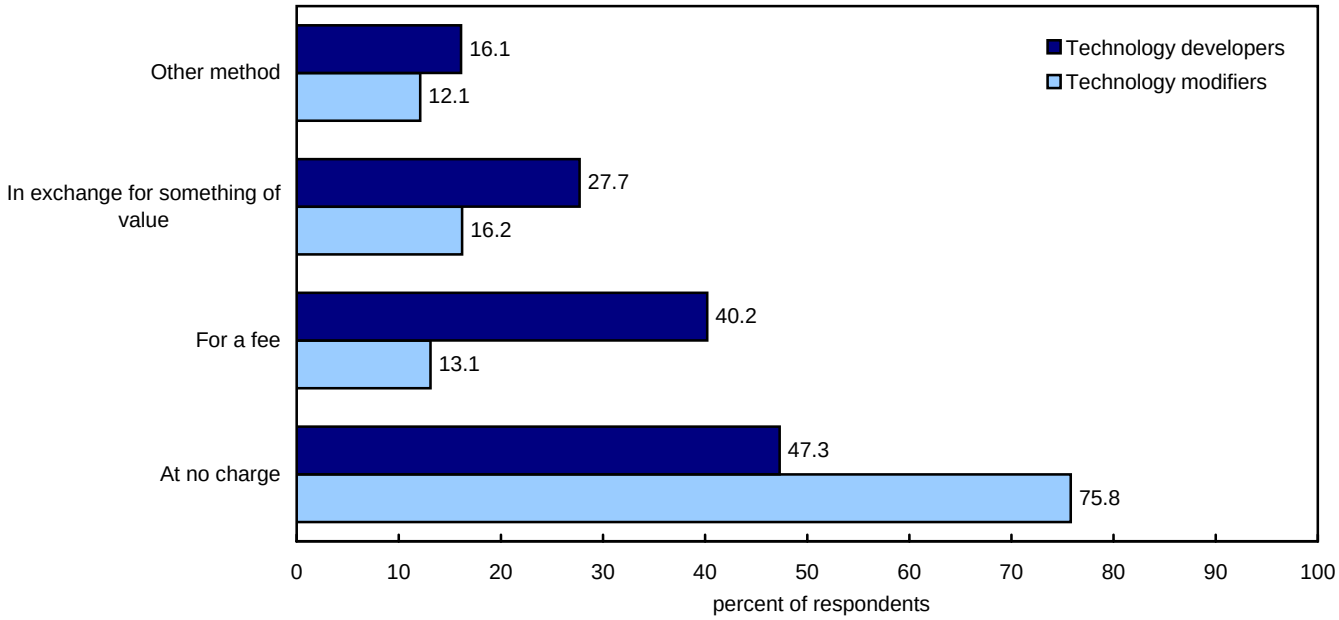
Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

Responses of technology modifiers and technology developers indicate that although they are just as likely to share their user innovations it is not a common activity for either type of user innovator with fewer than one in five plants doing so (17.2% modifiers and 18.8% developers). In spite of this, it is important to note that innovations are being diffused in the economy and there is opportunity to increase this diffusion rate. The sharing of user innovations creates linkages as part of the innovation process. Clearly these plants are contributors to innovation, however it is not known whether the beneficiary of the sharing would recognize or acknowledge the plants as the source of the innovation when responding to questions on traditional innovation surveys.

Responses of technology modifiers and technology developers show that the most common way to share among both types of user innovators is at no charge (Chart 27). That said, technology modifiers are more likely than developers to share at no charge, with three quarters (75.8%) of technology modifiers who responded indicating they share at no charge compared to less than one half (47.3%) of technology developers. On the other hand, technology developers are three times more likely than technology modifiers to share for a fee and are more likely to share in exchange for something of value.

Chart 27

Percent of technology developer and technology modifier respondents that shared indicating how they shared the new technologies they developed or technologies they modified with other plants, firms or institutions[1]



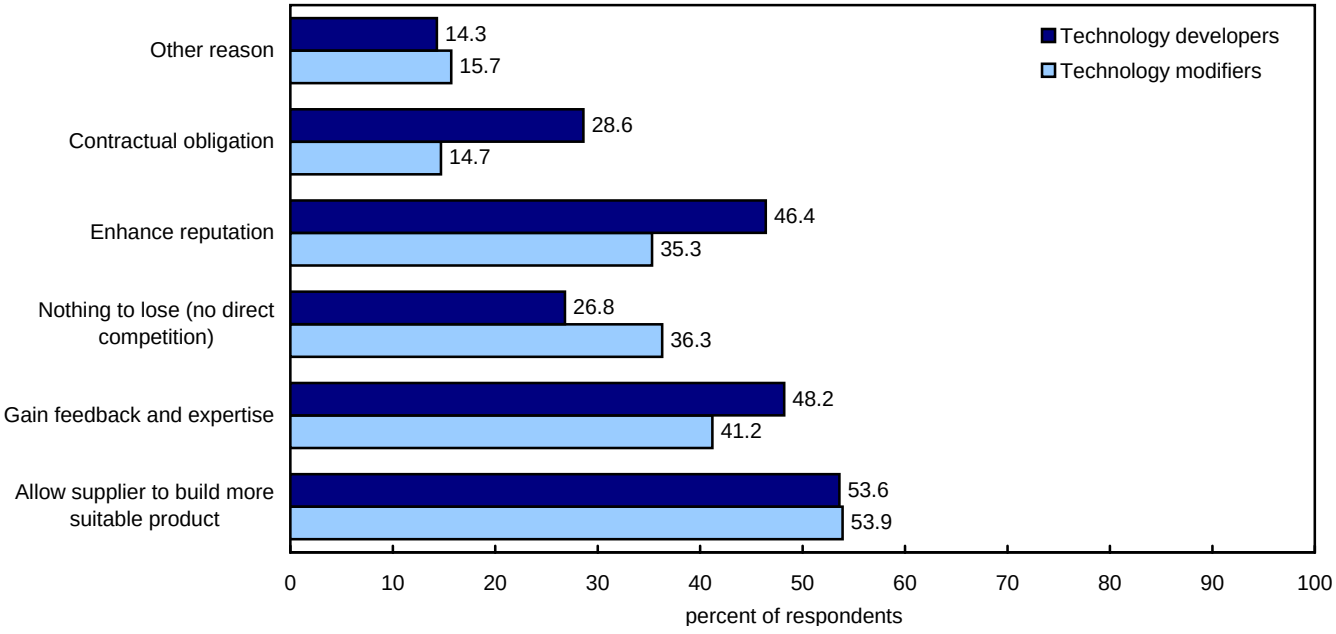
1. Estimates based on 99 responses of technology modifiers resulting in a 93.4% response rate and 112 responses of technology developers resulting in a 99.1% response rate.

Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

Among the technology modifiers and developers who indicated they shared the technologies they modified or developed, the most commonly indicated reason for sharing was to allow a supplier to build a more suitable final product (Chart 28). The next most indicated reasons, gaining feedback and expertise and enhancing reputation, were indicated more frequently by technology developers than technology modifiers. Responses provided suggest that a larger percentage of technology developers recognize the advantages gained by sharing.

Chart 28

Percent of technology developer and technology modifier respondents indicating the reasons for sharing the new technologies they developed or technologies they modified, with other plants, firms or institutions[1]



1. Estimates based on 102 responses of technology modifiers resulting in a 96.2% response rate and 112 responses of technology developers resulting in a 99.1% response rate.

Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

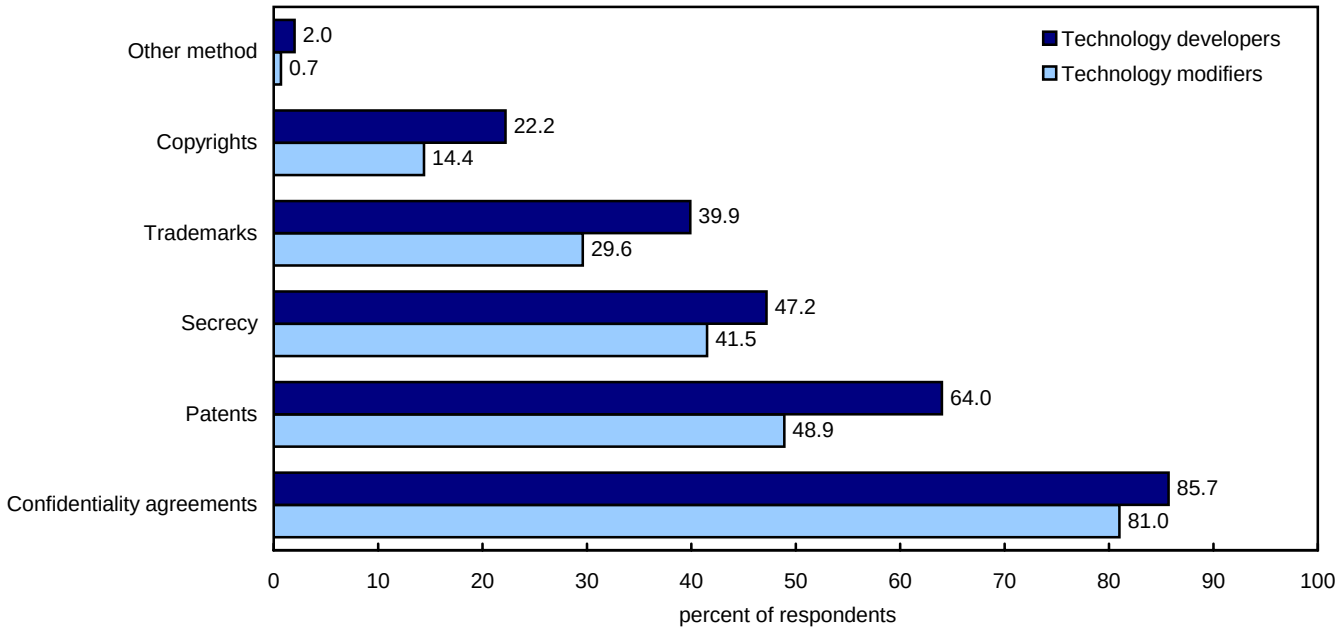
One in four (26.8%) technology developers who responded indicated they had nothing to lose by sharing compared to one in three (36.3%) technology modifiers. This suggests that a larger percentage of technology modifiers may be less concerned with competition than technology developers. Technology developer respondents were almost twice as likely as technology modifiers to indicate they shared as a result of a contractual obligation so although they did share, it is not known whether sharing would have occurred without a legal motivator.

Six in ten (60.3%) technology developers that responded indicated they protected the intellectual property resulting from their user innovations compared to less than half (46.4%) of technology modifiers. Although von Hippel and de Jong (2008) found a lower incidence of use of intellectual property protection than this study they too found that technology developers protected their intellectual property more often than technology modifiers.

Among plants that protected intellectual property, confidentiality agreements were by far the most frequently indicated method used by both technology developers and technology modifiers (Chart 29). Although the relative use of each method among technology developers and modifiers follows the same hierarchical order, technology developers have a consistently larger percentage of plants using each method compared to technology modifiers.

Chart 29

Percent of technology developer and technology modifier respondents that used methods to protect the intellectual property (IP) resulting from the development of new technologies or modification of technologies indicating methods used[1]



1. Estimates based on 284 responses of technology modifiers resulting in a 99.0% response rate and 356 responses of technology developers resulting in a 98.3% response rate.

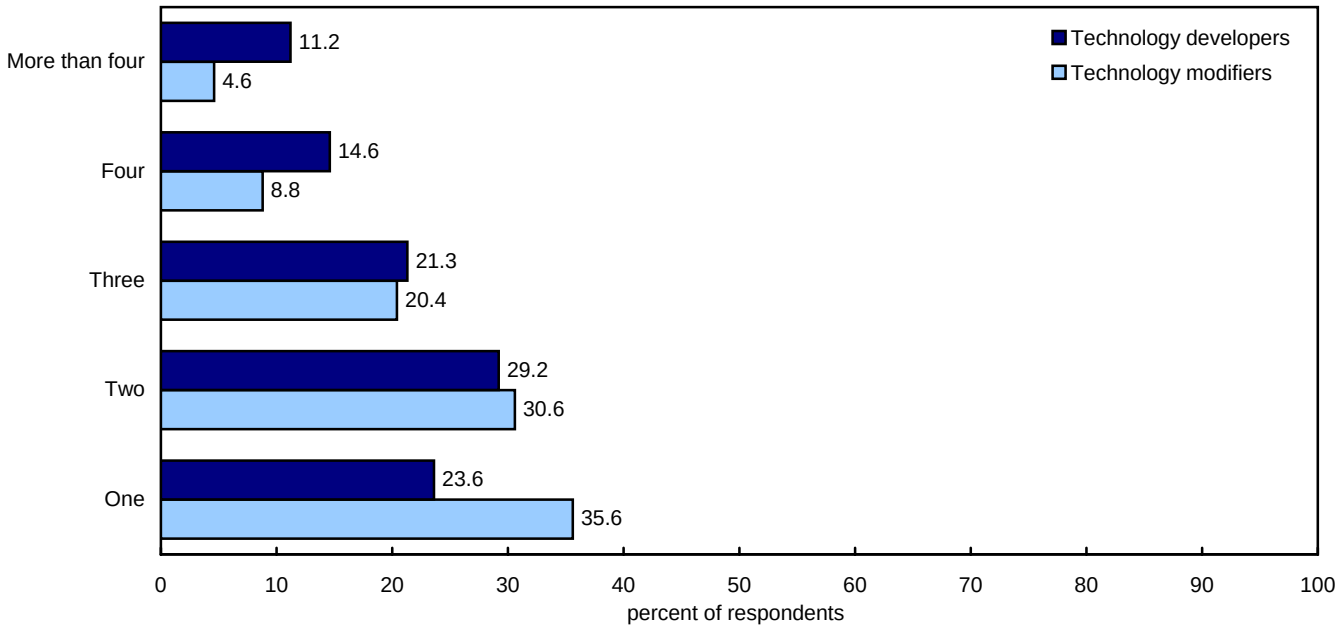
Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

Presumably, plants that are developing new technologies would have more novel innovations than those modifying existing technologies. It would be expected that plants with more novel innovations would have a greater propensity to use intellectual property protection methods than plants without novel innovations. This remains to be explored.

Technology developers are more likely to use a greater number of methods to protect the intellectual property of their user innovations than technology modifiers (Chart 30). Technology developers are most likely to use two methods whereas technology modifiers are most likely to use one.

Chart 30

Number of methods of intellectual property protection used in the plant for protecting the plant's developed new technologies or modified technologies for technology developer and technology modifier respondents[1]



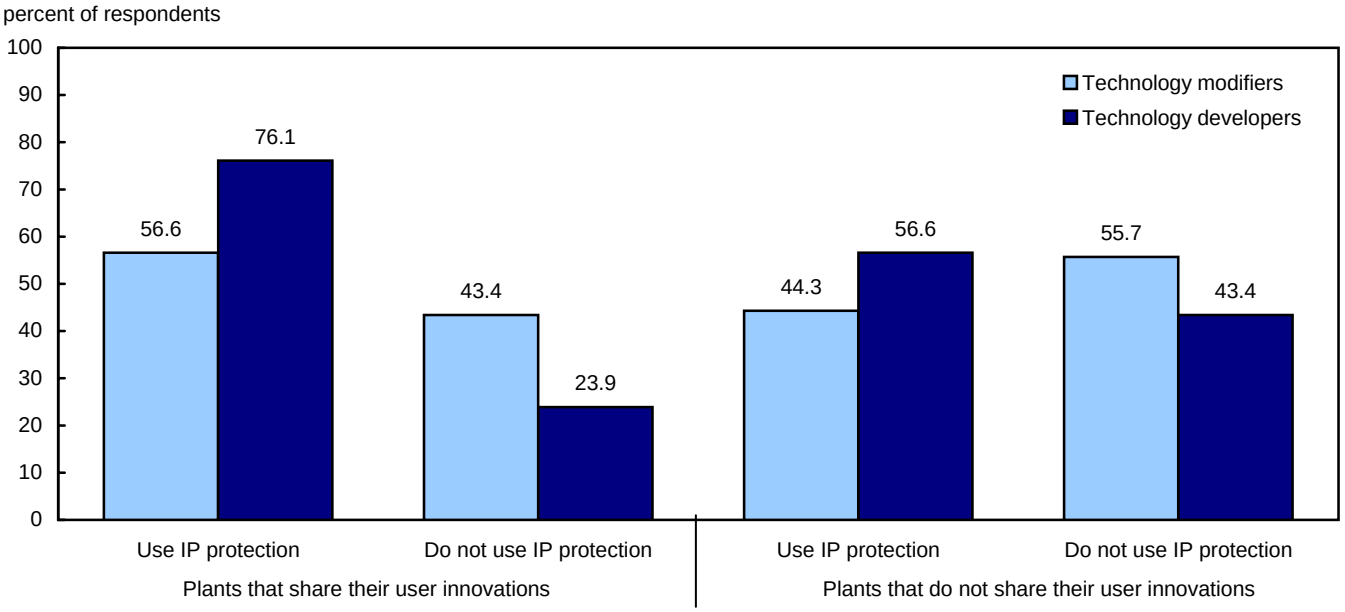
1. Estimates based on 284 responses of technology modifiers resulting in a 99.0% response rate and 356 responses of technology developers resulting in a 98.3% response rate.

Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

There is debate on the impact of intellectual property protection on the stimulation or hindrance of innovation. More than three in four (76.1%) technology developers and more than half (56.6%) of technology modifiers who responded that they shared the new technology developments also responded that they protected the intellectual property resulting from their user innovations (Chart 31). Although not as common, still more than half (56.6%) of technology developers and 44.3% of technology modifiers who responded they do not share their user innovations indicated they protected the resulting intellectual property. Did the use of intellectual property protection methods increase the likelihood of sharing? This cannot be answered with existing data; However it should be explored. What can be said is that technology developers and technology modifiers who share their user innovations are more likely to protect the intellectual property of their user innovations than plants that do not share.

Chart 31

Percent of technology developer[1] and technology modifier[2] respondents indicating whether they share their user innovations and whether they use methods to protect the intellectual property (IP) resulting from the user innovations



1. Estimates based on 618 responses of technology modifiers resulting in a 100.0% response rate.
2. Estimates based on 599 responses of technology modifiers resulting in a 99.7% response rate.

Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

The taxonomy of plant type considers the degree of effort required for each method of technology adoption increases as the complexity of the introduction method. As the complexity of the introduction method increases so does the need for internal capabilities. As a result, it would be expected that it would be more costly and time consuming to develop new technologies than it would take to modify an existing technology. Responses provided by technology modifiers and developers on costs and time spent on their most recent user innovation project agree with this hypothesis. The average total cost of labour to develop the most recently developed new technology was almost twice the average cost to modify the most recently modified existing technology and median costs almost four times as large (Table 2). The average cost of machinery, equipment and materials was 40% higher and median cost almost double for technology developers than for technology modifiers. The total overall cost for the most recent technology development project was 59.7% higher than the cost of the most recent technology modification project.

Text table 2

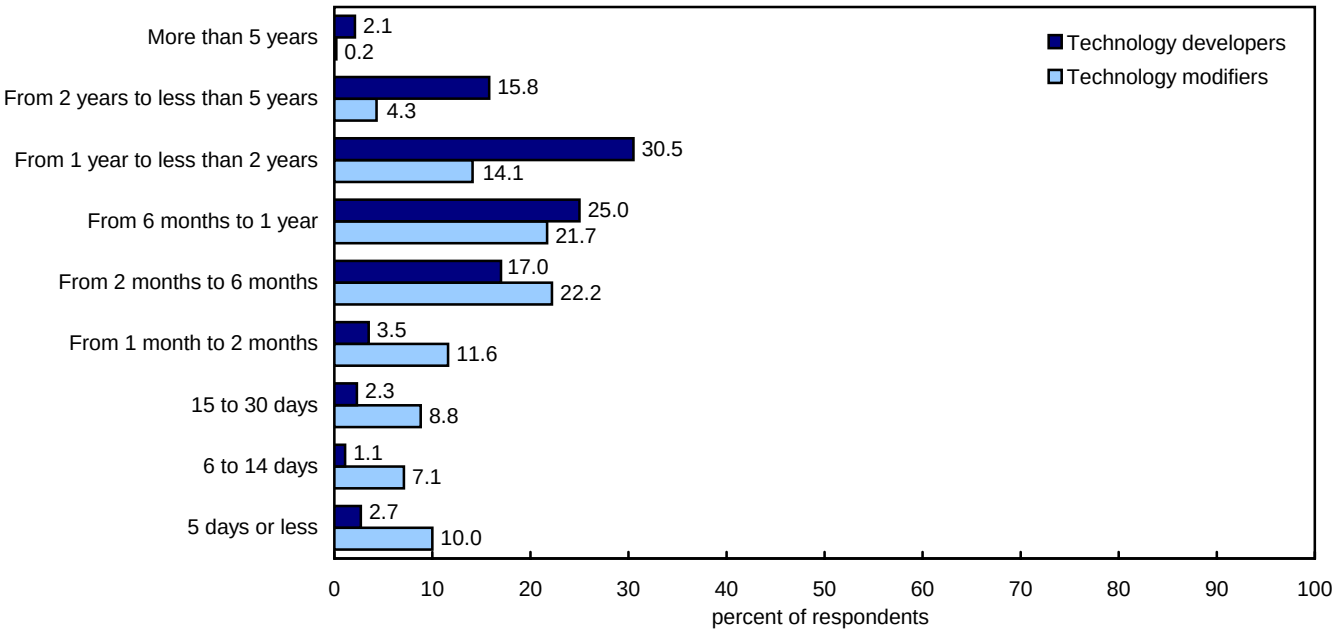
Average and median costs associated with the most recently developed new technology or most recently modified existing technology

	User innovator type		Percent difference
	Technology modifier	Technology developer	
Average total cost of labour	228,604	427,863	87.2
Average cost of machinery, equipment, and materials	405,564	567,966	40.0
Average total cost	**630,742**	**1,007,345**	**59.7**
Median total cost of labour	20,000	77,123	385.6
Median cost of machinery, equipment, and materials	40,000	75,000	87.5
Median total cost	**70,250**	**200,000**	**284.7**

Source(s): Statistics Canada, Survey of Advanced Technology 2007.

Not surprisingly, projects for the development of new technologies take longer than modification of existing ones. Technology developers who responded were more likely than technology modifiers to take upwards of 6 months in elapsed time to complete their most recently developed or modified technology (Chart 32). Conversely, technology modifiers who responded were more likely than technology developers to take 6 months or less.

Chart 32
Percent of technology developer and technology modifier respondents indicating the estimated elapsed time required to complete the development of their most recently developed new technology or modification of their most recently modified technology[1]



1. Estimates based on 580 responses of technology modifiers resulting in a 93.9% response rate and 564 responses of technology developers resulting in a 93.8% response rate.

Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

3 Measurement issues and lessons learned

Statistics Canada's first survey of user innovation has successfully shown that respondents are able and willing to complete questions on user innovation activities allowing the production of some metrics. Cognitive testing of the questionnaire with potential respondents and incorporation of respondent feedback into the final version of the questionnaire is considered as a key factor in attaining the high overall response rate (73%), achieved with the mailing of one reminder card and no telephone follow-up. Further, this response rate is consistent for both the sample of technology modifiers (72.1%) and technology developers (73.9%). Among the completed questionnaires, individual question non response was highest for the quantitative questions (response rates were lowest for these questions). These included total cost of labour for technology modification or development with response rates of 88.0% and 86.9% respectively and total cost of machinery and equipment for modification or development with response rates of 87.1% and 84.9% respectively. If imputation had been used for item non response, the imputation rate per question would have only reached a maximum of 15.1%. It should be noted that the sample for the Follow-up to the Survey of Advanced Technology 2007 was taken from respondents to the Survey of Advanced Technology 2007. These respondents had already indicated a willingness to respond to Statistics Canada surveys. A stand-alone survey may not yield as high a response rate.

Analysis of survey results has allowed description of some innovation activities of user innovators. The survey has shown that the activities of technology modifiers and developers have some marked differences. When possible, attempts should be made to distinguish these two sub-populations to facilitate detailed study.

Respondent-supplied information where respondents specified a response other than the options provided will help improve future survey questionnaires. For example, among respondents who specified a funding source other than the three options provided, a large percentage specified that the development or modification of technologies was government-funded; some even provided the name of the program such as the SR&ED tax credit program, NRC-IRAP, and grants.

von Hippel (2005) describes user innovation as development or modification of technologies for use within a plant to enhance operations when specific process needs cannot be met by existing market solutions. Regardless of whether this technology ultimately becomes a product that is sold, the original intention was to have it used by the plant itself. These differ from technologies created with the intention of marketing and selling them as a product. The formulation of a simple description allowing respondents to make this distinction proved problematic. During cognitive testing of the questionnaire attempts were made to qualify the activity of technology modification or development to restrict it to user innovation; However, despite several attempts, a simple question could not be formulated. Businesses communicated that if their modification or development projects were not going to be used as part of the firm's operations then they would not carry them out. They considered product sales as part of the plant's operations, being used by the plant to enhance revenues. This measurement issue remains unresolved.

Cognitive testing revealed that the identification of technology modification by respondents was not always clear. This was most apparent in cases of use of design software. Some manufacturing plants interpreted that specification of input such as that required in a CAD program was modification of the software by the user to meet their needs. The distinction between the application of software and the modification of software's source code could not be conveyed in a manner where it was understood the same way as was intended. Ultimately, this affected 1.5% of technology modifiers who contacted Statistics Canada for clarification during data collection. This proportion reflects a lower limit as it would be expected that not all respondents would necessarily seek this clarification. Future surveys will need to consider this in questionnaire design.

The development of indicators for the cost of technology modifications or the development of new technologies also proved problematic during questionnaire testing in three general areas. First, respondents communicated that projects could be diverse making it difficult to provide an annual cost figure. They were able to describe individual projects. The questionnaire was modified to direct reporting on the "most recently developed new technology" or "most recent modification", as appropriate although bias towards larger projects in the respondents' recollection has been recognized.

Second, the target respondent was the CEO and he did not necessarily have the detailed information to provide cost information from an accounting perspective. Respondents were not sure how to report. Coupled with this was a reluctance to provide detailed cost figures. As a result, respondents were asked to provide information for three indicators of the cost of user innovation: cost of labour time; average cost of machinery, equipment and materials; and time required to complete the most recent project.

Third, during cognitive testing of the questionnaire several respondents explained that personnel may be involved in one or more projects with varying degrees of time commitments. This is reflected in the responses to the Follow-up to the Survey of Advanced Technology 2007 which show that almost two-thirds of technology modification projects and one half of technology development projects were carried out on an occasional basis which can help explain why reporting cost information is difficult. The use of units of measure such as person hours made responding too difficult during questionnaire testing. To resolve this, the qualification that the time required to complete modification or development projects be "elapsed time" was included in response to respondent feedback that this was an easier number to derive. An indicator of commitment of personnel was measured by cost of total labour. Finally, a question on the cost of machinery, equipment, and materials required to develop or modify the technology was included to complete the picture. High response rates by technology modifiers and developers (Appendix A, Table A) show that respondents were willing and able to provide this information.

Surveys of innovation ask questions on new or significantly improved processes. The qualifier "significant" is open to interpretation and it can be argued that some innovative activities are being overlooked or discounted. We have learned that one third of technology modifiers who responded to the Follow-up to the Survey of Advanced Technology and more than one half of technology developers carried out these activities as part of the maintenance budget. This

raises the question of whether a traditional innovation survey question on process innovation would capture activities that fall under a heading of “maintenance”. Adding to this, 15.3% of technology developers and 12.3% of technology modifiers specified a budget not included in the supplied options. A preliminary analysis of these responses indicates a high percentage specified that user innovation was funded as part of the operating budget or as part of capital expenditures, raising concerns that these activities could be overlooked when responding to a traditional survey of innovation.

4 Conclusions

User innovation is a common activity among Canadian manufacturing plants that use advanced technologies. In 2007, one in five (20.7%) manufacturing plants that had introduced advanced technologies were technology modifiers and an equal proportion (21.8%) were technology developers. Taken together, this provides an indicator for user-innovation with one in ten (42.5%) manufacturing plants that introduced advanced technologies having carried out user-innovation in 2007.

Questions still remain unresolved as to whether traditional innovation survey questions are completely capturing innovation activities. Although 42.5% of plants that introduced advanced technologies were user innovators, only 61.2% of these plants were found to be process innovators during the years 2004 to 2007. Did the remaining 38.8% of user innovators carry out their process innovation outside the reference period? Without a reference period for the user innovation activity no firm conclusions can be drawn regarding the efficiency of the traditional innovation question on process innovation. What can be concluded is that half (50.6%) of process innovators that used advanced technologies also had a user innovation highlighting the importance of this activity to innovation overall.

User innovators are an important contributor to, and source of information for, innovation with their activities creating linkages with other actors in the innovation system. Survey results have shown that about one in six technology modifiers shared the technologies they modified with other firms or institutions and about one in five technology developers shared the new technologies they developed. Further, user innovators have a high incidence of cooperation on their projects. Six out of ten user innovative manufacturing plants indicated they cooperated for the modification or development of new technologies (55.5% of technology modifiers and 65.1% of technology developers). This is three times the incidence of cooperation for innovation activities in general.[8] Clearly user innovators play a role in the innovation system.

User innovations are being shared, most commonly at no charge. About one in five (18.0%) user innovators shared their user innovations with other firms or institutions with more than half (53.7%) of these plants choosing to share in order to allow a supplier to build a more suitable final product. The most common way to share for both technology modifiers and technology developers is at no charge. Gault and von Hippel (2009) develop the intellectual property policy implications of these findings.

User innovations are being diffused in the Canadian economy. One in four (26.3%) user innovators indicated that their user innovations were adopted by another manufacturing firm to produce and supply the new or modified technology and one in four (25.3%) indicated their user innovations were adopted by other firms. This evidence of innovation diffusion makes user innovators an important actor in the innovation system.

Lack of funds within the plant or firm was one of two obstacles to innovation[9] most frequently identified as having high importance (Survey of Innovation 2005). Government support programs such as the R&D tax credit program are aimed at increasing innovation. Half of user innovators had a dedicated budget for each project. Four in ten indicated they used their R&D budget and four in ten their maintenance budget. Only one in ten user innovators indicated they used their innovation budget to fund their user innovations. One explanation could be that in plants where user innovation is not part of a formal program of technology adoption and/or is carried out occasionally there

8. The Survey of Innovation 2005 found that 21.5% of innovative manufacturing plants cooperated on their innovation activities with other firms or institutions during the years 2002 to 2004.
9. Inability to devote staff to innovation projects on an on-going basis because of production requirements is the other obstacle.

is no dedicated innovation budget in the plant. Understanding how plants approach user innovation in their activities and treat it in their accounting can help government design programs to promote and support user innovation.

The analysis in this paper has been on the manufacturing industry overall however recent work by von Hippel and de Jong (2008) has shown that incidence of user innovation varies by industry and by firm size. It would be interesting to explore whether industrial differentiation exists at a finer level of detail within manufacturing as well as by size class. In addition, the statistical measurement of incidence of user innovation in a broad range of industries of varying size classes would provide a better indicator of the prevalence of this activity and contribute to a better understanding of innovation in Canadian industry. Firm size remains to be explored in analysis of user innovation.

Future work on user innovation should explore the linkages, including the flow of information, between user innovators and other actors in the innovation system. This study has made use of data from a pilot survey. A statistical survey program of innovation including questions on user innovation would allow better indicators of this activity in the Canadian economy.

5 References

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Appendix A — Statistical tables of survey results

Text table A

Statistical tables of survey results and response rates by question for user innovators (all), technology modifiers, and technology developers

Question	Question number	User innovators		
		All	Modifiers	Developers
		percent		
Frequency of technology modification or development (response rate)	**1**	**99.9**	**100.0**	**99.8**
Response				
Continuous		42.5	35.3	50.0
Occasional		57.5	64.7	50.0
Type of technology adoption program (response rate)	**2**	**99.5**	**99.7**	**99.3**
Response				
Formal		28.2	20.1	36.5
Informal		71.8	79.9	63.5
Funding of technology modification or development (response rate)	**3**	**99.7**	**99.5**	**99.8**
Response				
Internally		98.4	98.2	98.5
By customers		12.3	7.8	16.8
By suppliers		9.5	6.0	13.0
Other funding		8.4	6.0	10.8
Only funded internally		76.4	83.3	69.3
Number of funding sources indicated				
One		77.9	84.9	70.7
Two		16.4	12.5	20.3
More than one		22.1	15.1	29.3
More than two		5.8	2.6	9.0
Budget used for technology modification or development (response rate)	**4**	**97.9**	**98.1**	**97.8**
Response				
Part of the research and developement budget		39.4	30.5	48.6
Dedicated budget for each project		46.3	48.8	43.7
Part of the maintenance budget		39.4	49.2	29.4
Other budget		12.6	11.4	13.8
Part of the innovation budget		9.9	10.2	9.5
Number of budgets indicated				
One		63.7	62.4	65.1
Two		26.3	26.6	26.0
Three		8.6	9.6	7.7
More than three		1.3	1.5	1.2
Other firms with similar technology modifications or developments (response rate)	**5**	**99.1**	**99.5**	**98.7**
Response				
Yes		41.1	38.0	44.2
No		58.9	62.0	55.8
Cooperation with others for technology modifications or development (response rate)	**6**	**99.8**	**100.0**	**99.7**
Response				
Yes		60.2	55.5	65.1
No		39.8	44.5	34.9

Text table A – continued

Statistical tables of survey results and response rates by question for user innovators (all), technology modifiers, and technology developers

Question	Question number	User innovators		
		All	Modifiers	Developers
		percent		
Who cooperated with for technology modifications or developments (response rate)	**7**	**98.8**	**98.8**	**98.2**
Response				
Other plants in the firm		54.3	57.8	51.4
Suppliers of equipment, materials, components, or software		83.6	85.5	82.2
Clients or customers		43.6	34.5	52.0
Competitors or other firms in the sector		10.8	8.8	12.5
Consultants		40.9	41.6	40.5
Commercial labs or research and development enterprises		16.6	10.6	21.9
Universities or other higher education institutions		22.2	12.7	30.8
Colleges or technical institutes		8.7	5.6	11.5
Federal government labs or research institutes		10.1	5.9	13.8
Provincial or territorial labs or research institutes		4.4	2.4	6.3
Private non-profit research institutes		3.0	1.2	4.7
Industrial associations		16.9	15.6	18.0
Other type		1.2	0.6	1.8
Number of cooperation partners				
One		15.3	18.3	12.8
Two		24.3	28.0	21.1
Three		26.9	27.1	26.9
Four		15.9	14.2	17.5
Five		8.1	7.7	8.6
More than five		9.4	4.7	13.6
Sharing technology modifications or developments (response rate)	**8**	**99.9**	**100.0**	**99.8**
Response				
Yes		18.0	17.2	18.8
No		82.0	82.8	81.2
How technology modifications or developments are shared (response rate)	**9**	**96.3**	**93.4**	**99.1**
Response				
At no charge		60.7	75.8	47.3
In exchange for something of value		22.3	16.2	27.7
For a fee		27.5	13.1	40.2
Other method		14.2	12.1	16.1
Reasons why chose to share technology modifications or developments (response rate)	**10**	**97.7**	**96.2**	**99.1**
Response				
Allow supplier to build more suitable product		53.7	53.9	53.6
Enhance reputation		41.1	35.3	46.4
Gain feedback and expertise		44.9	41.2	48.2
Contractual obligation		22.0	14.7	28.6
Nothing to lose (no direct competition)		31.3	36.3	26.8
Other		15.0	15.7	14.3

Text table A – continued

Statistical tables of survey results and response rates by question for user innovators (all), technology modifiers, and technology developers

Question	Question number	User innovators		
		All	Modifiers	Developers
		percent		
Use of intellectual property protection for technology modification or development (response rate)	**11**	**99.9**	**100.0**	**99.8**
Response				
Yes		53.3	46.4	60.3
No		46.7	53.6	39.7
Intellectual property protection methods used (response rate)	**12**	**98.6**	**99.0**	**98.3**
Response				
Confidentiality agreements		83.6	81.0	85.7
Patents		57.3	48.9	64.0
Secrecy		44.7	41.5	47.2
Trademarks		35.3	29.6	39.9
Copyrights		18.8	14.4	22.2
Other		1.4	0.7	2.0
Number of intellectual property protection methods used				
One		28.9	35.6	23.6
Two		29.8	30.6	29.2
Three		20.9	20.4	21.3
Four		12.0	8.8	14.6
More than four		8.3	4.6	11.2

Question	Question number	User innovators					
		All		Modifiers		Developers	
		response	response rate	response	response rate	response	response rate
		percent					
Adoption of technology modification or development by others	**13**						
Another manufacturing firm to produce the technology		26.3	93.8	25.2	93.0	27.4	94.7
Another firm to use the technology		25.3	90.7	23.9	91.3	26.8	90.2
		dollars	percent	dollars	percent	dollars	percent
Average total cost of labour for technology modification or development	**14**	326,177	87.4	228,604	88.0	427,863	86.9
Median total cost of labour for technology modification or development		45,000	...	20,000	...	77,123	...
Average total cost of machinery, equipment, and materials for technology modification or development	**15**	484,595	86.0	405,564	87.1	567,966	84.9
Median total cost of machinery, equipment, and materials for technology modification or development		50,000	...	40,000	...	75,000	...

Text table A – continued

Statistical tables of survey results and response rates by question for user innovators (all), technology modifiers, and technology developers

Question	Question number	User innovators		
		All	Modifiers	Developers
		percent		
Elapsed time required to complete technology modification or development (response rate)	**16**	**93.8**	**93.9**	**93.8**
response				
5 days or less		6.4	10.0	2.7
6 to 14 days		4.1	7.1	1.1
15 to 30 days		5.6	8.8	2.3
From 1 month to 2 months		7.6	11.6	3.5
From 2 months to 6 months		19.7	22.2	17.0
From 6 months to 1 year		23.3	21.7	25.0
From 1 year to less than 2 years		22.2	14.1	30.5
From 2 years to less than 5 years		10.0	4.3	15.8
More than 5 years		1.1	0.2	2.1

Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

Text table B

Statistical tables of survey results and response rates for cross tabulations of questions for technology modifiers and developers, Follow-up to the Survey of Advanced Technology 2007

Question	Question number	User innovators		
		All	Modifiers	Developers
		percent		
Frequency of technology modification or development and type of technology adoption program (response rate)	**1 and 2**	**99.4**	**99.7**	**99.2**
Response				
Carried out continuously and as part of a formal program of technology adoption		18.6	10.7	26.8
Carried out continuously and as part of an informal program of technology adoption		23.8	24.5	23.0
Carried out occasionally and as part of a formal program of technology adoption		9.6	9.4	9.7
Carried out occasionally and as part of an informal program of technology adoption		48.0	55.4	40.4
Have a formal program of technology adoption (response rate)	**1 and 2**	**99.4**	**99.7**	**99.2**
Response				
Occasionally develop or modify technologies		33.9	46.8	26.6
Continuously develop or modify technologies		66.1	53.2	73.4
Have an informal program of technology adoption				
Occasionally develop or modify technologies		66.9	69.3	63.8
Continuously develop or modify technologies		33.1	30.7	36.2
Share and protect intellectual property (response rate)	**8 and 11**	**99.8**	**100.0**	**99.7**
Response		66.7	56.6	76.1
Methods used for intellectual property protection (response rate)	**8, 11 and 12**	**99.3**	**100.0**	**98.8**
Response				
Confidentiality agreements		86.2	80.0	90.6
Patents		53.1	41.7	61.2
Secrecy		49.0	51.7	47.1
Trademarks		33.8	26.7	38.8
Copyrights		22.1	13.3	28.2
Other		4.1	1.7	5.9
Do not share and protect intellectual property (response rate)	**8 and 11**	**99.8**	**100.0**	**99.7**
Response		50.3	...	...
Methods used for intellectual property protection (response rate)	**8, 11 and 12**	**98.4**	**98.7**	**98.2**
Response				
Confidentiality agreements		82.8	81.3	84.1
Patents		58.5	50.9	64.8
Secrecy		43.5	38.8	47.4
Trademarks		35.8	30.4	40.4
Copyrights		17.8	14.7	20.4
Other		0.6	0.4	0.7

Question	Question number	User innovators					
		All		Modifiers		Developers	
		Response	Response rate	Response	Response rate	Response	Response rate
		dollars	percent	dollars	percent	dollars	percent
Average total cost of most recently developed or modified technology	**14 and 15**	815,580	84.7	630,742	85.1	1,007,345	84.4
Median total cost of most recently developed or modified technology		125,000	...	70,250	...	200,000	...

Source(s): Statistics Canada, Follow-up to the Survey of Advanced Technology 2007.

Appendix B — Catalogued publications

Science, Technology and Innovation statistical publications

88-001-X	*Science statistics*
88-003-X	*Innovation analysis bulletin*
88-202-X	*Industrial research and development, intentions (with 2004 preliminary estimates and 2003 actual expenditures) (annual)*
88-204-X	*Federal scientific activities (annual)*
88F0006X	*Business Special Surveys and Technology Statistics Division working papers*
88F0017M	*Science, Innovation and Electronic Information Division research papers*

88-001-X Volume 33 – 2009

No. 1	Biotechnology scientific activities in federal government departments and agencies, 2007/2008 (March)
No. 2	Estimates of Total Spending on Research and Development in the Health Field in Canada, 1997 to 2008 (March)
No. 3	Research and Development Personnel in Canada, 1997 to 2006 (June)
No. 4	Industrial Research and Development, 2005 to 2009 (July)
No. 5	Estimates of Research and Development Expenditures in the Higher Education Sector, 2007/2008 (September)

88-001-X Volume 32 – 2008

No. 1	Research and Development Personnel (R&D) - 1996 to 2005 (May)
No. 2	Biotechnology Scientific Activities in Federal Government Departments and Agencies, 2006/2007 June)
No. 3	Estimates of Total Spending on Research and Development in the Health Field in Canada, 1996 to 2007(July)
No. 4	Estimation of Research and Development Expenditures in the Higher Education sector, 2006/2007 (August)
No. 5	Industrial Research and Development, 2004 to 2008 (September)
No. 6	Scientific and Technological Activities of Provincial Governments and Provincial Research Organizations, 2002/2003 to 2006/2007 (October)
No. 7	Federal Government Expenditures on Scientific Activities, 2008/2009 Intentions (November)

88-001-X Volume 31 – 2007

No. 1	Research and development (R&D) personnel in Canada, 1995 to 2004 (January)
No. 2	Estimates of total spending on research and development (R&D) in the health field in Canada, 1989 to 2006 (March)
No. 3	Biotechnology scientific activities in federal government departments and agencies, 2005/2006 (May)
No. 4	Estimation of research and development expenditures in the higher education sector, 2005/2006 (August)

No. 5 Scientific and Technological (S&T) Activities of Provincial Governments and Provincial Research Organizations, 2001/2002 to 2005/2006 (October)
No. 6 Industrial research and development, 2003 to 2007 (November)
No. 7 Federal government expenditures on scientific activities, 2007/2008 (intentions) (December)
No. 8 Gross Domestic Expenditure on Research and Development, 2007 intentions (December)

88-001-X Volume 30 – 2006

No. 1 Distribution of federal expenditures on science and technology, by province and territories, 2003/2004 (February)
No. 2 Biotechnology scientific activities in federal government departments and agencies, 2004/2005 (March)
No. 3 Estimates of total spending on research and development in the health field in Canada, 1988 to 2005 (May)
No. 4 Industrial Research and Development, 2002 to 2006 (August)
No. 5 Estimation of research and development expenditures in the higher education sector, 2004/2005 (August)
No. 6 Federal government expenditures on scientific activities, 2006/2007 (September)
No. 7 Total spending on research and development in Canada, 1990 to 2006, and provinces, 1990 to 2004 (September)
No. 8 Nature of Research and Development, 2000 to 2004 (December)
No. 9 Distribution of federal expenditures on science and technology by province and territories, 2004/2005 (December)

88-001-X Volume 29 – 2005

No. 1 Distribution of federal expenditures on science and technology by province and territories, 2002-2003 (January)
No. 2 Research and development (R&D) personnel in Canada, 1993 to 2002 (May)
No. 3 Biotechnology scientific activities in federal government departments and agencies, 2003-2004 (May)
No. 4 Industrial research and development, 2001 to 2005 (June)
No. 5 Estimates of total spending on research and development in the health field in Canada, 1988 to 2004 (July)
No. 6 Estimation of research and development expenditures in the higher education sector, 2003-04 (December)
No. 7 Federal government expenditures on scientific activities, 2005/2006(December)
No. 8 Total spending on research and development in Canada, 1990 to 2005p, and provinces, 1990 to 2003 (December)

88F0006X Working papers – 2009

No. 1 *Results from the Functional Foods and Natural Health Products Survey – 2007 (July)*
No. 2 *Innovation in the Canadian Manufacturing Sector: Results from the Survey of Innovation 2005 (August)*

88F0006X Working papers – 2008

No. 1 *Innovative Exporters and Intellectual Property Regimes in Selected Service Industries: Evidence from the Canadian Survey of Innovation 2003 (February)*
No. 2 *The Business of Nurturing Businesses (March)*

No. 3 *Understanding Internet Usage Among Broadband Households: A Study of Household Internet Use Survey Data*

88F0006X Working papers – 2007

No. 1 *Innovativeness and Export Orientation Among Establishments in Knowledge-Intensive Business Services (KIBS), 2003 (April)*
No. 2 *Where Are the Scientists and Engineers? (April)*
No. 3 *Results from the Functional Foods and Nutraceuticals Survey - 2005 (May)*

88F0006X Working papers – 2006

No. 1 *Provincial distribution of federal expenditures and personnel on science and technology, 1997/1998 to 2003/2004 (April)*
No. 2 *Buying and selling research and development services, 1997 to 2002 (May)*
No. 3 *Characteristics of Growth Firms, 2004/2005 (May)*
No. 4 *Scientific and Technological Activities of Provincial Governments and Provincial Research Organizations, 2000/2001 to 2004/2005 (July)*
No. 5 *Research and Development in the Field of Advanced Materials, 2001 to 2003 (July)*
No. 6 *Conceptualizing and Measuring Business Incubation (July)*
No. 7 *Characteristics of Business Incubation in Canada, 2005 (July)*
No. 8 *Size and Persistence of R&D Performance in Canadian Firms, 1994 to 2002 (August)*
No. 9 *Estimates of Canadian Research and Development Expenditures (GERD), Canada, 1995 to 2006, and by Province 1995 to 2004 (September)*
No. 10 *Are Small Businesses Positioning Themselves for Growth? A Comparative Look at the Use of Selected Management Practices by Firm Size (October)*
No. 11 *Survey of Intellectual Property Commercialization in the Higher Education Sector, 2004 (October)*
No. 12 *Provincial Distribution of Federal Expenditures and Personnel on Science and Technology (December)*

88F0006X Working papers – 2005

No. 1 *Federal government expenditures and personnel in the natural and social sciences, 1995/96 to 2004/05 (January)*
No. 2 *Provincial distribution of federal expenditures and personnel on science and technology, 1996-97 to 2002-03 (January)*
No. 3 *Industrial R&D statistics by region, 1994 to 2002 (January)*
No. 4 *Knowledge sharing succeeds: how selected service industries rated the importance of using knowledge management practices to their success (February)*
No. 5 *Characteristics of firms that grow from small to medium size: Industrial and geographic distribution of small high-growth firms (February)*
No. 6 *Summary: Joint Statistics Canada – University of Windsor workshop on intellectual property commercialization indicators, Windsor, November 2004 (March)*
No. 7 *Summary: Meeting on commercialization measurement, indicators, gaps and frameworks, Ottawa, December 2004 (March)*
No. 8 *Estimates of research and development personnel in Canada, 1979 to 2002 (May)*
No. 9 *Overview of the biotechnology use and development survey – 2003 (April)*
No. 10 *Access to financing capital by Canadian innovative biotechnology firms (April)*
No. 11 *Scientific and technological activities of provincial governments and provincial research organizations, 1995-96 to 2003-04 (September)*

No. 12 *Innovation in Information and Communication Technology (ICT) sector service industries: Results from the Survey of Innovation 2003 (October)*
No. 13 *Innovation in selected professional, scientific and technical services: Results from the Survey of Innovation 2003 (October)*
No. 14 *Innovation in selected transportation industries: Results from the Survey of Innovation 2003 (November)*
No. 15 *Innovation in selected industries serving the mining and forestry sectors: Results from the Survey of Innovation 2003 (November)*
No. 16 *Functional foods and nutraceuticals: The development of value-added food by Canadian firms (September)*
No. 17 *Industrial R&D statistics by region 1994 to 2003 (November)*
No. 18 *Survey of intellectual property commercialization in the higher education sector, 2003 (November)*
No. 19 *Estimation of research and development expenditures in the higher education sector, 2003-2004 (December)*
No. 20 *Estimates of Canadian research and development expenditures (GERD), Canada, 1994 to 2005, and by province 1994 to 2003 (December)*