Cat. No. 88F0006XIB01004

Innovation, Advanced Technologies and Practices in the Construction and Related Industries: National Estimates

Statistics Canada Statistique Canada

Canada

Innovation, Advanced Technologies and Practices in the Construction and Related Industries: National Estimates

Survey of Innovation, Advanced Technologies and Practices in the *Construction and Related Industries*

1999

Frances Anderson and Susan Schaan

Science, Innovation and Electronic Information Division

February 2001

88F0006XIB No. 04

This working paper is the result of a collaborative project between the Science, Innovation and Electronic Information Division, Statistics Canada and the Institute for Research in Construction, National Research Council of Canada

Working Paper Series

The Working Paper Series publishes research related to science and technology issues. All papers are subject to internal review. The views expressed in the articles are those of the authors and do not necessarily reflect the views of Statistics Canada nor, in this case, the views of the National Research Council of Canada.

CONTACTS FOR MORE INFORMATION

Science, Innovation and Electronic Information Division

Director Dr. F.D. Gault (613-951-2198)

Assistant Director Brian Nemes (613-951-2530)
Assistant Director Paul McPhie (613-951-9038)

The Science and Innovation Information Program

Chief, Indicators Development
Dr. Frances Anderson (613-951-6307)

Chief, Knowledge Indicators
Michael Bordt (613-951-8585)

Chief, Innovation
Daood Hamdani (613-951-3490)

Chief, Science and Innovation Surveys
Bert Plaus (613-951-6347)

Chief, Life Science Unit
Antoine Rose (613-951-9919)

FAX: (613-951-9920)

The Science and Innovation Information Program

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

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

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

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

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

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

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

The final version of the framework that guides the future elaboration of indicators was published in December, 1998 (**Science and Technology Activities and Impacts: A Framework for a Statistical**

Information System, Cat. No. 88-522). The framework has given rise to **A Five-Year Strategic Plan for the Development of an Information System for Science and Technology** (Cat. No. 88-523).

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

The working papers and research papers are available at no cost on the Statistics Canada Internet site at http://www.statcan.ca/english/research/scilist.htm.

Table of Contents

Preface

The study of the adoption and dissemination of technologies and practices is one of the key components of innovation and technological development. Indeed, it is through the adoption of newer, more advanced, technologies and practices that industries can increase their production capabilities, improve their productivity, and expand their lines of new products and services.

Surveys of the adoption of new technologies and practices and complement other information we collect about R&D and innovation, by allowing us to measure in what way and how quickly industries adapt to technological and organizational change.

The 1999 Survey of Innovation, Advanced Technologies and Practices in the Construction and Related Industries is the first survey of the advanced technologies and practices in the construction sector. Four surveys of advanced manufacturing technologies were carried out in 1987, 1989, 1993 and 1998; two surveys of the use of biotechnologies were carried out in 1996 and 2000; and one survey of electronic commerce and technology was carried out in 1999 and one is currently in the field.

This research paper is the result of a joint 3-year collaborative project with the Institute for Research in Construction of the National Research Council of Canada and the Science, Innovation and Electronic Information Division of Statistics Canada. The broad objective of the project is to measure, understand and assess innovation, advanced technologies and practices of the Canadian construction sector with a view to developing new policies and programs.

As production processes in construction are significantly different from those found in the manufacturing sector, listings of advanced manufacturing technologies that are currently used were not considered to be appropriate descriptors. Consequently, a listing of advanced technologies and advanced practices that are specific to the construction sector was developed in consultation with industry experts.

Executive Summary

The Survey

The Survey of Innovation, Advanced Technologies and Practices in the Construction and Related Industries was conducted by Statistics Canada during the spring and summer of 1999. The questionnaire was designed by a working group formed by the Science, Innovation and Electronic Information Division of Statistics Canada and the Institute for Research in Construction of the National Research Council of Canada, with the participation of the Canadian Construction Research Board.

Business Environment

Construction industries perceive their environment to be very competitive. Almost two thirds of the businesses consider that their clients can easily find a substitute for their services and that the arrival of new competitors is a constant threat. Only one third of the businesses consider that the actions of their competitors are easy to predict

Success Factors

For construction industries, building and enhancing relations with current clients and attracting new clients were considered to be the two most important business strategy factor with over 80% of the businesses rating these two factors to be of importance. Ensuring employees are aware of business issues was also rated to be of importance by more than two thirds of businesses.

Advanced Technologies

Of all the technologies surveyed, three computer related technologies had the highest percentage of use: e-mail (38%), company computer networks (25%) and computer aided design (23%).

Planned use of technologies within two years is also highest for a number of computer related technologies: e-mail (25%), computer-aided design (15%), electronic exchange of CAD files (14%) and digital photography for progress reporting (12%).

Advanced Practices

The three advanced practices with the largest percentage of business using them, each with approximately one third of businesses using them are: design-build contracts, computerized inventory control and computerized estimating software. Planned use of the last two of these practices for the next 2 years is the highest among all practices (at 20% and 23% respectively). Planned use of design-build contracts is relatively low at 7%.

Mergers, Acquisitions and Expansions

The larger the business the more likely it is to be involved in mergers, acquisition and expansions. Large businesses were particularly active during the three year period surveyed, with one in five businesses acquiring another business and more than one in three setting up a new line of business or a new division.

Source of Information

Suppliers of materials, supplies, machinery and equipment are the source of information on advanced technologies and advanced practices for the largest percentage of businesses, three quarters of the businesses indicating this source. Trade journals and newsletters were the source of information for one half of the businesses, followed by clients which were the source of information for 44%. Consulting engineers and general contractors were the source of information for 4 of 10 of the businesses.

Obstacles

The high cost of products, systems and equipment was greatest obstacle to using new and improved building products, building systems and construction equipment as perceived by 70% of businesses. Shortage of workers was the second most widespread obstacle, as perceived by more than 40% of businesses.

Acknowledgements

The work of the Statistics Canada/NRC Working Group was critical in the design of the questionnaire and development of the general conceptual approach to innovation in construction that has guided the broader study. Participants of the working group are: from NRC: Aaron Bellamy, Olga Berseneff, Hakim Elmahdy, André Manseau, and Chris Norris; from Statistics Canada: Frances Anderson, Susan Schaan and Brian Nemes; from the Canadian Construction Research Board: Ed Cuylits and Gordon Walt; from the University of Ottawa, Faculty of Administration: George Seaden; and from Carleton University, Institute for Interdisciplinary Studies: Rob Shields.

The questionnaire mail-out and collection/data capture was carried out by Science and Innovation Survey Section of the Science, Innovation and Electronic Information Division, under the direction of Bert Plaus, with Heather Prieur as the project manager.

The Business Survey Methods Division was responsible for the methodology of the survey. In particular, the authors would like to thank Yves Morin and John Bentley.

The testing of the questionnaire was done by Statistics Canada's Questionnaire Design Resource Centre and was carried out by Allan Gower and Marie-Josée Williams.

Finally, the authors would like to thank the 1800 construction businesses who completed the questionnaire. Without their cooperation and goodwill, this working paper would not exist.

Introduction

This working paper is the first in a series of studies that results from a collaborative project between the Science, Innovation and Electronic Information Division of Statistics Canada and the Institute for Research in Construction of the National Research Council of Canada, with the participation of the Canadian Construction Research Board. The objective of the project is to measure, understand and assess innovation, advanced technologies and advanced practices through the examination of patterns, processes and performance of the Canadian construction sector with an ultimate view to developing policies and programs.

Over the last decade, innovation and advanced technology surveys have been carried out in many countries, including Canada. For the most part, these surveys have concentrated on the manufacturing sector and more recently on the service sector, but there has been little work done on surveying the construction sector. The *Survey of Innovation, Advanced Technology and Practices in the Construction and Related Industry- 1999* is the first Canadian effort to measure innovation, advanced technologies and practices in the construction sector.

In the initial discussions of the NRC/Statistics Canada working group which developed the *Survey of Innovation, Advanced Technology and Practices in the Construction and Related Industries- 1999* consideration was given to surveying construction with the same survey instrument that has been developed to survey manufacturing. After considerable deliberation, such an approach was not adopted. In the following passages an account is given of the major considerations of the working group on the nature of innovation and of advanced technologies and practices which have been critical in the design of the current survey.

The Construction Production System

It was the view of the working group that there were a number of very important differences between the construction production process and the manufacturing production process and because of these differences a different approach was required. Brady and Shapiro's (1999) discussion "complex product systems" (COPS) is useful to understand the difference between the construction and the mass-production manufacturing productions systems.

> "(Complex product systems – COPS) are produced on a project basis for specific customers and markets…. Many of the innovation and production processes of COPS do not conform to conventional models derived from research in mass production industries. For COPS, the nature of the production process is very different with greater emphasis on software development, systems integration and project management rather than on manufacturing and other repeated tasks." (Brady and Shapiro, 1999)

The construction production system is thus characterized by its project-based organization. Work is carried out on a construction or building site, not in a factory, and the final result of the process is a custom-designed, custom-made complex product, not a standard mass produced product.

Given these important differences, the working group sought to develop an approach that would use the key defining concepts of innovation- product, process and organizational practices- as outlined in the *Oslo Manual* and apply these key concepts to the special case of the construction sector.

Product

In the view of the working group, the construction industries are essentially assembly operations. Products (old or innovative) are produced in the manufacturing sector. These manufactured products flow from the manufacturing sector into the construction industries where they become components of sub-systems and these sub-systems become part of the final complex product system- the built structure, be it a building, a bridge, a railway, etc. For example, light fixtures from a manufacturer become a component of an electrical system that is installed in a building or in the lighting system of a highway. This being the case, the construction industries are essentially adopters of innovative products, as opposed to the producer of innovative products.

The adoption and integration of innovative products can require considerable change on the construction or building site as these innovative products must be integrated into pre-existing sub-systems or complex product system. Methods and procedures of installation might have to change and the skills set of the workers might not be adequate to deal with the new innovative products.

Asking the construction sector whether or not they developed new or significantly improved products, which is the way the innovation question is most often phrased in innovation surveys, was judged to be an inappropriate one for construction industries because the purpose of the construction production system is not to produce innovative products but rather to assemble complex product systems. The more critical question, if one wants to understand innovation in construction industries, is that of the obstacles to and impact of the flow of innovative products into construction industries, as well of the extent of the diffusion of certain key innovative products. Questions were developed for the current questionnaire to address these issues.

Process

In the view of the working group, production processes in construction are also significantly different from those of the manufacturing sector. Existing listings of advanced manufacturing technologies were not considered to be appropriate descriptors of construction production processes. A listing of technologies that are specific to the construction sector was developed.

Process innovation in construction is of three types: logistical technologies (bringing products to the site), site preparation (preparing the land) and assembling technologies (putting the components together to build the final structure). Innovation in heavy equipment and construction tools are key drivers of change on the construction or building site, along with the development new installation practices. As in the case of products, machinery and equipment are produced in the manufacturing sector, not in the construction industries and new equipment and machinery can also require significant changes on the work site in terms of installation practices and the skill sets of the workers.

Organizational practices

Innovation can be a new or significantly improved product (goods or services), process or organizational practice. Most innovation surveys that have been conducted to date measure product and process innovation. Only a more limited number of surveys have measured organizational practice innovation.

An important hypothesis that the working group wanted to test was that the most successful construction businesses are those that have adopted "modern management practices" or, in other terms, have adopted the more innovative of the practices that are currently available. A listing of advanced construction practices was developed by the working group which includes the four following types of practices: computerization, quality, organizational and business.

1. The Survey

Questionnaire development

The questionnaire was designed jointly by a joint working group formed by the Science, Innovation and Electronic Information Division of Statistics Canada and the Institute for Research in Construction of the National Research Council of Canada. It was developed with input of industry experts in the working group as well as from input from industrial associations with whom consultations were held and round tables were organized. Testing of the questionnaire was carried out to ensure that the questions were well understood by industry respondents.

Characteristics and Coverage

The Survey of Innovation, Advanced Technologies and Practices in the Construction and Related Industries was conducted by Statistics Canada during the spring and summer of 1999. It was based on a list of businesses classified to construction industries taken from the Statistics Canada's Business Register.

The survey consists of eight sections with questions on business environment; success factors; use and planned use of advanced technologies; use and planned use of advanced practices; mergers, acquisitions and expansions; sources of information; obstacles; and impact.

Sampling Methodology

A total of 147,634 sample units were defined from Statistics Canada's Business Register. The sampling unit used in the 1997 Unified Enterprise Survey (UES) for Construction was neither at the enterprise nor the establishment level, rather, it was a grouping (or cluster) of establishments. Within each province for each enterprise, all establishments of the same NAICS (North American Industrial Classification System) 6-digit code were grouped to form one sampling unit or "pseudo enterprise". To reduce response burden, businesses with revenues less than $50,000 were not included in the population.

The sample was randomly drawn from the population of pseudo enterprises that was stratified by province and industry size class. Fourteen industry categories based on NAICS codes were used. Details of the industry codes used are found in Annex 1.

A sample of roughly 2,500 units was drawn. Questionnaires were sent only to those businesses that had responded to the 1997 Unified Enterprise Survey of Construction, to ensure that the data from the Innovation, Advanced Technologies and Practices survey data could be linked to the production data contained in the 1997 Survey of Construction. Data could then be presented based on size. In this document revenue sizes are: small- $50,000-$999,999; medium- $1 million-$9,999,999; and large- $10 million and over.

Data Collection

Questionnaires were mailed out to the Chief Executive Officer (CEO) of businesses. Mail, telephone and fax follow-ups were then carried out for non-respondents.

Response and Non-response

The overall response rate for the survey was 75%, for a total of 1,800 completed questionnaires.

Sampling Error

Answers to the survey questions presented in this report are population estimates, that is, they represent the percentage of businesses in the population that exhibit a particular characteristic. The population estimates are generated through the application of sample weights when tabulations are generated. Business weights for the survey are equal to the inverse of the sampling rate.

As the sample drawn for this survey is but one of many possible samples that could have been drawn, there is a sampling error attributed to it. Standard errors are used to provide a guide as to the reliability of the results.

The reliability of the data has been assessed using the following convention:

Code	Rating	Standard Error
A	Very good	<2.5%
B	Good	>2.5% and <7.5%
C	Good to poor- use with caution	>7.5 and<15%
D	Very poor- may not be acceptable	≥15%

In the text that follows estimates with a rating of "C" are indicated by an "*" and in the annex they are shaded. Estimates with a rating of "D" have not been presented and have been replaced by "…". All other estimates in the text and the annex are of "A" or "B" rating.

Advanced technologies and practices

There are 18 advanced technologies and 12 advanced practices listed in this survey. These two listings were developed by the joint Statistics Canada/NRC working group in consultation with industry representatives. See the questionnaire in Annex 3 for definitions of the advanced technologies and practices.

2. Construction Business Environment

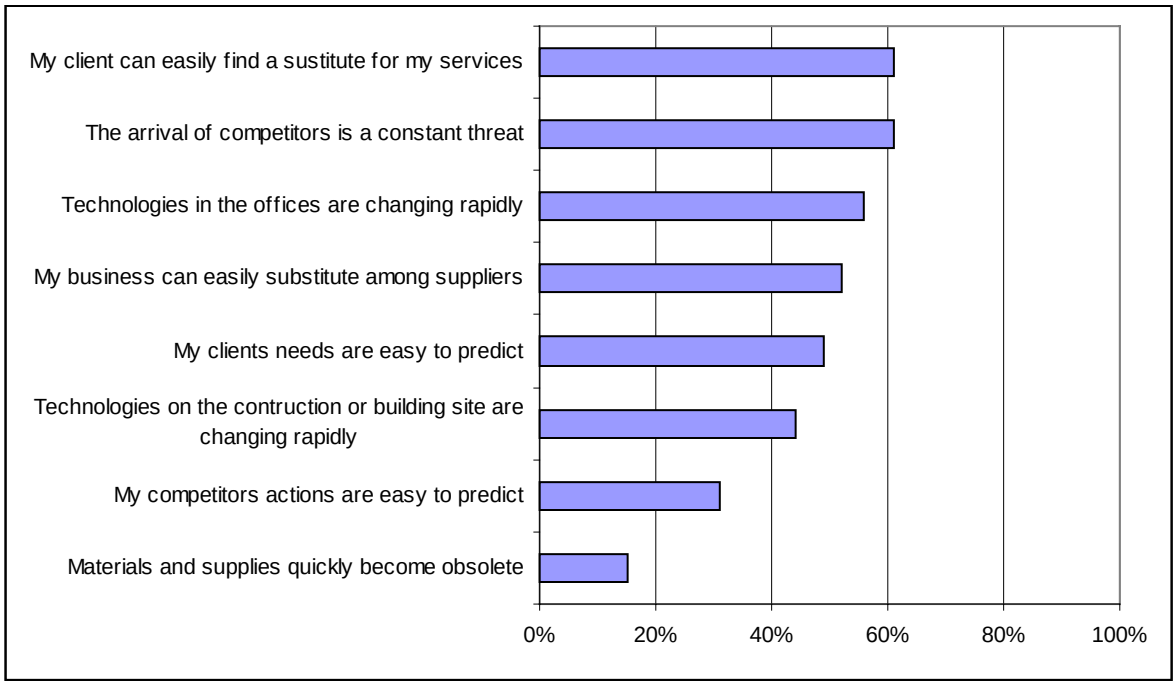
The environment in which construction businesses operate will be the subject of this section. First, the business environment of the construction industries as a whole will be explored. This will be followed by an examination of the environment as perceived by businesses with different revenue sizes and businesses in different industries.

The construction industries perceive their environment to be very competitive. Almost two thirds of the businesses consider that their clients can easily find a substitute for their services and that the arrival of new competitors is a constant threat. Only one third of the businesses consider that the actions of their competitors are easy to predict.

On the supply side, one half of the businesses consider that they could easily substitute among suppliers and one half of the businesses consider that their clients needs are easy to predict. Perceptions on these two factors are thus evenly divided.

Technologies in the office are seen to be changing more rapidly than technologies on the construction or building site (56% compared to 44%) and only a relatively small percentage of business consider that material and supplies become quickly obsolete.

Figure 1
Construction Business Environment: Percentage of Businesses Agreeing with Statements, All Industries



***** Respondents responded using a scale from 1 to 5, where 1 is strongly disagree and 5 is strongly agree. "Agreeing" indicates a response of 4 or 5.

The perception of the business environment, in certain cases, appears to be related to the size of the business. The sharpest difference involves the perception of the rate of change of technologies in the office. Whereas one half of the smaller businesses consider technologies in the office to be changing rapidly, two-thirds of medium or larger ones perceive rapid change. A higher percentage of medium sized businesses consider that material and supplies become quickly obsolete than do the smaller and larger businesses.

Table 1
Construction Business Environment: Percentage of Businesses Agreeing with Statements, by Revenue Size

	Small	Medium	Large	All
My client can easily find a substitute for my services	62%	52%	62%	61%
The arrival of competitors is a constant threat	62%	58%	56%	61%
Technologies in the offices are changing rapidly	54%	66%	69%	56%
My business can easily substitute among suppliers	51%	55%	50%	52%
My clients needs are easy to predict	50%*	43%	52%	49%
Technologies on the construction or building site are changing rapidly	43%*	46%	41%	44%
My competitors actions are easy to predict	31%*	32%	29%	31%
Materials and supplies quickly become obsolete	14%	21%	11%	15%

*An asterisk (*) in the table indicates that the data has a "C" reliability and is "good to poor" reliability. This data should be used with caution. See p.14 for detail.

There are significant differences in the perception of the business environment by different industries (See Annex 2, Table 1) For example, 38% of "Electrical Work" businesses perceive that their clients can easily find a substitute for their services, 91% of businesses in roofing are of this view. In terms of the perception of the rate of change of technologies on the construction or building site, just over a quarter of businesses in "Building Structures" perceive technologies to be changing rapidly, whereas more than one half of "Building Interior" and "Equipment Installation" businesses perceive that technologies are changing rapidly.

3. Success Factors

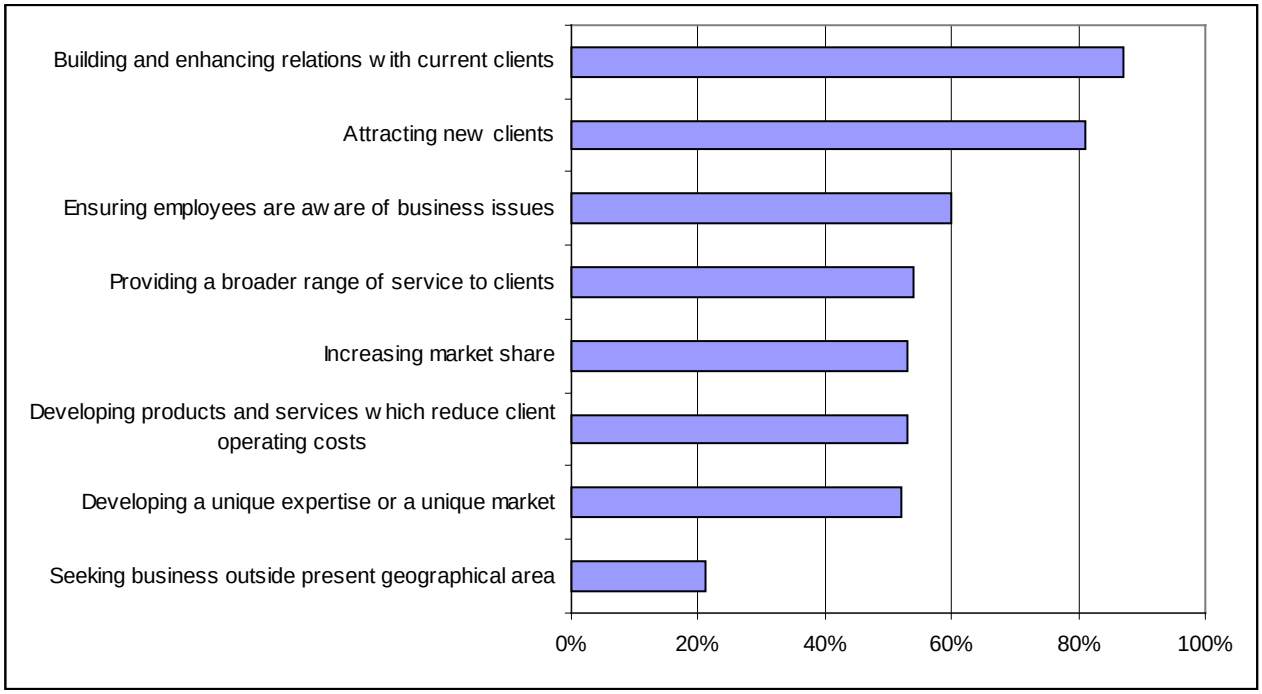
Construction businesses were requested to rate the importance of a number of factors to the success of their business. Three types of factors were considered: business strategy factors; human resource factors; and technological factors. This section will explore each of these types of factors in turn.

Business Strategies

For construction industries as a whole, building and enhancing relations with current clients and attracting new clients were considered to be the two most important business strategy factor with over 80% of the businesses rating these two factors to be of importance. Ensuring employees are aware of business issues was also rated to be of importance by more than two thirds of businesses.

Half of the businesses considered four factors to be of importance: providing a broader range of service to clients, increasing market share, developing products and services which reduce client operating costs, and developing a unique expertise or a unique market. Seeking business outside their present geographical area is considered to be an important factor in business success by only one fifth of businesses.

Figure 2
Business Strategy Factors of Business Success: Percentage of Businesses Rating Factors to be of Importance*, All Industries



* Respondents responded using a scale from 1 to 5, where 1 is low importance and 5 is high importance or the respondents indicated that the factor was "not relevant". "Importance" indicates a response of 4 or 5.

In the case of four of the business strategies, size is an important factor. The larger the business the more it perceived that the following factors contribute to its business success: increasing its market share, developing products and services which reduce client operating costs, developing a unique expertise or a unique market, and seeking business outside its present geographical area.

Table 2
Business Strategy Factors of Business Success: Percentage of Businesses Rating Factors to be of Importance, by Revenue Size

Business Factors	Small	Medium	Large	All
Building and enhancing relations with current clients	86%	92%	89%	87%
Attracting new clients	79%	91%	88%	81%
Ensuring employees are aware of business issues	61%	55%	65%	60%
Providing a broader range of service to clients	55%	49%	56%	54%
Increasing market share	49%	69%	74%	53%
Developing products and services which reduce client operating costs	52%	59%	62%	53%
Developing a unique expertise or a unique market	51%	58%	69%	52%
Seeking business outside present geographical area	19%	35%	36%	21%

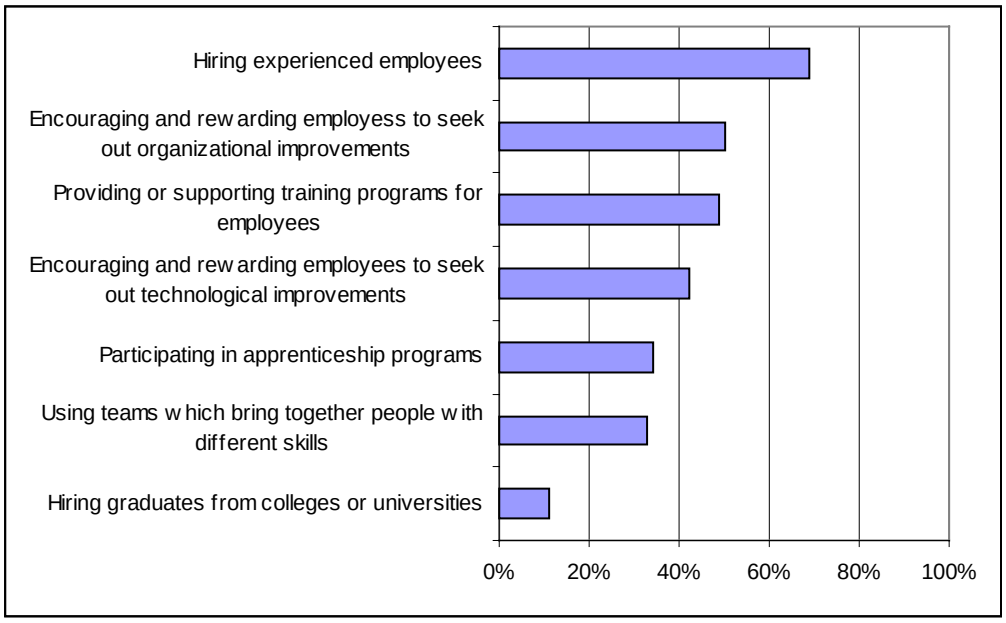
There is considerable variation between industries as to strategies that are perceived to contribute to business success (See Annex 1, Table 2). Two of the industries, "Building Interior Finishing" and "Building Equipment Installation", have the highest percentage of businesses perceiving their business success is related to several of the marketing strategies including: developing a unique expertise or a unique market, seeking business outside of their present geographical region of activities, increasing their market share and providing a broader range of services to their clients.

Human Resource Factors

Hiring experience employees is perceived to be the most important human resource factor contributing to business success, with almost 70% of businesses citing its importance. Encouraging and rewarding employees to seek out organizational improvement and providing or supporting training programs for employees were considered to be important factors in the businesses success by half of the businesses.

One third of businesses considered participating in apprenticeship programs and using teams which bring together people with different skills to be important to their business success and hiring graduates from colleges or universities was considered to be a business success factor by only a small percentage of the businesses (11%).

Figure 3
Human Resource Factors of Business Success: Percentage of Businesses Rating Factors to be of Importance, All Industries



In the most general terms, the larger the business the more importance it attributes to human resource factors in its business success.

Table 3
Human Resource Factors of Business Success: Percentage of Businesses Rating Factors to be of Importance, by Revenue Size

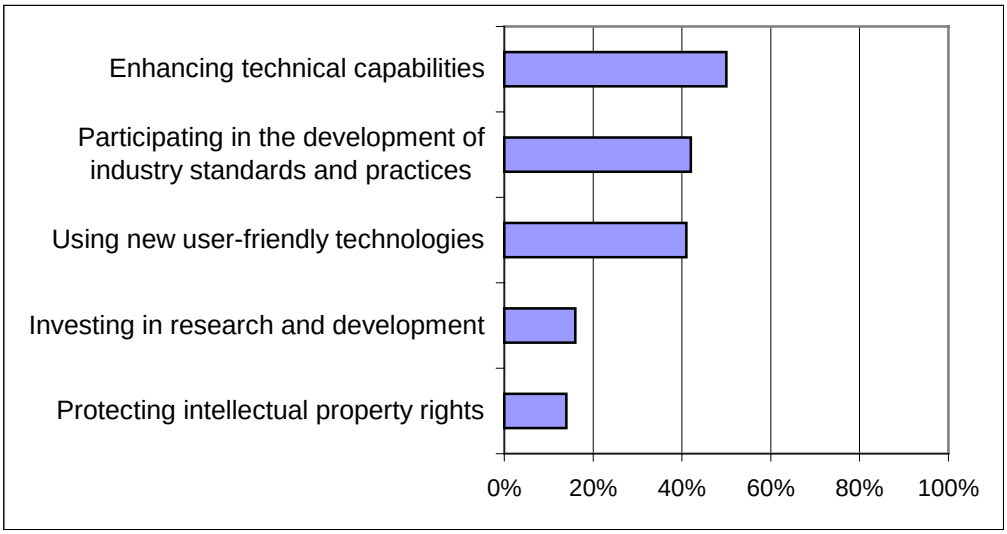
	Small	Medium	Large	All
Hiring experienced employees	67%	80%	80%	69%
Encouraging and rewarding employees to seek out organizational improvements	49%	53%	66%	50%
Providing or supporting training programs for employees	47%	63%	71%	49%
Encouraging and rewarding employees to seek out technological improvements	42%	43%	58%	42%
Participating in apprenticeship programs	31%	48%	51%	34%
Using teams which bring together people with different skills	31%	44%	51%	33%
Hiring graduates from colleges or universities	9%	18%	30%	11%

There is considerable difference between different industries' perceptions of the importance of human resource factors to business success. There is a very sharp contrast between "Equipment Installation" businesses which, in general, perceives the importance of human resource factors to be of the most important and "Building Structures" in which the businesses perceive these factors as, generally, of the lowest importance. (Annex 2, Table 2)

Technological Factors

Enhancing technical capabilities was chosen by the highest percentage of firms (51%). This was followed by participating in the development of industry standards and practices and using new user-friendly technologies (42% and 41% respectively). Relatively few businesses considered investing in research and development and protecting intellectual property rights to be of importance to their business success (16% and 14% respectively).

Figure 4
Technological Factors of Business Success: Percentage of Businesses Rating Factors to be of Importance, All Industries



Three of the technological factors are related to the size of the business. Larger businesses perceive enhancing their technical capabilities, participating in the development of industry standards and practices, and using new user-friendly technologies as contributing more to their business success than do smaller businesses. As for the importance of investing in research and development and protecting intellectual property, businesses of all sizes perceive these factors to be of relatively low importance to the success of their businesses. The only exception to this is that medium-sized businesses have a slightly higher percentage of businesses that perceive the importance of protecting intellectual property as being an important factor.

Table 4
Technological Factors of Business Success: Percentage of Businesses Rating Factors to be of Importance, by Revenue Size

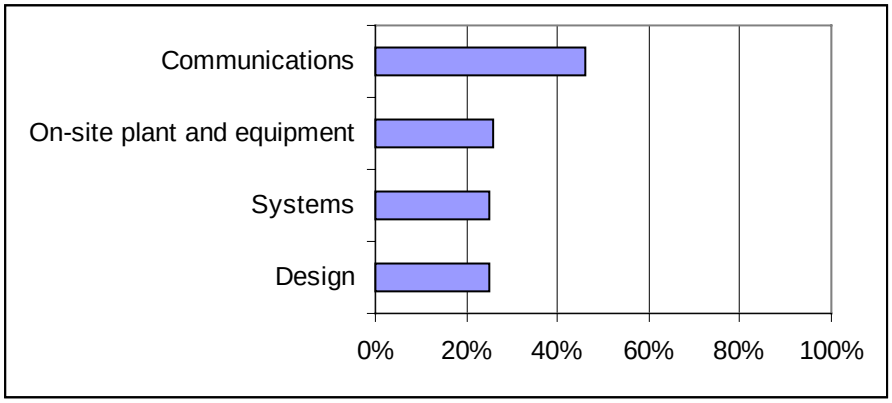
	Small	Medium	Large	All
Enhancing technical capabilities	49%	56%	65%	50%
Participating in the development of industry standards and practices	40%	51%	58%	42%
Using new user-friendly technologies	39%	53%	63%	41%
Investing in research and development	16%	17%	17%	16%
Protecting intellectual property	13%	17%	14%	14%

There are very sharp difference between industries as to the importance of technological factors for their business success. (See Annex 2, Table 2) Whereas only 4-5% of businesses in "Residential Construction" and "Non-Residential Construction" consider investing in research and development as being an important factor in their success, 40% of businesses in "Building Interior" and "Equipment Installation" are of this view. Enhancing technical capabilities is considered by only one quarter of businesses in "Residential Construction" and one half of businesses in "Non-Residential" as being important, whereas three quarters of businesses in "Equipment Installation" and "Electrical Works" consider this factor to be of importance to the success of their business.

4. Advanced Technologies

Businesses were asked to identify advanced technologies they are currently using and, if they were not currently using the technologies, to indicate whether they were planning to use the advanced technology within two years. Technologies were placed in five categories: communication technologies; materials; on-site plant and equipment; advanced systems; and design technologies. Of the five categories of technologies, communication technologies accounted for the highest percentage of use, with businesses reporting they used at least one of the technologies in the category. One in four businesses used at least one technology in the categories of on-site plant and equipment, systems, and design and one in five used new materials.

Figure 5
Percentage of Businesses Using at Least One Technology in a Category, All Industries

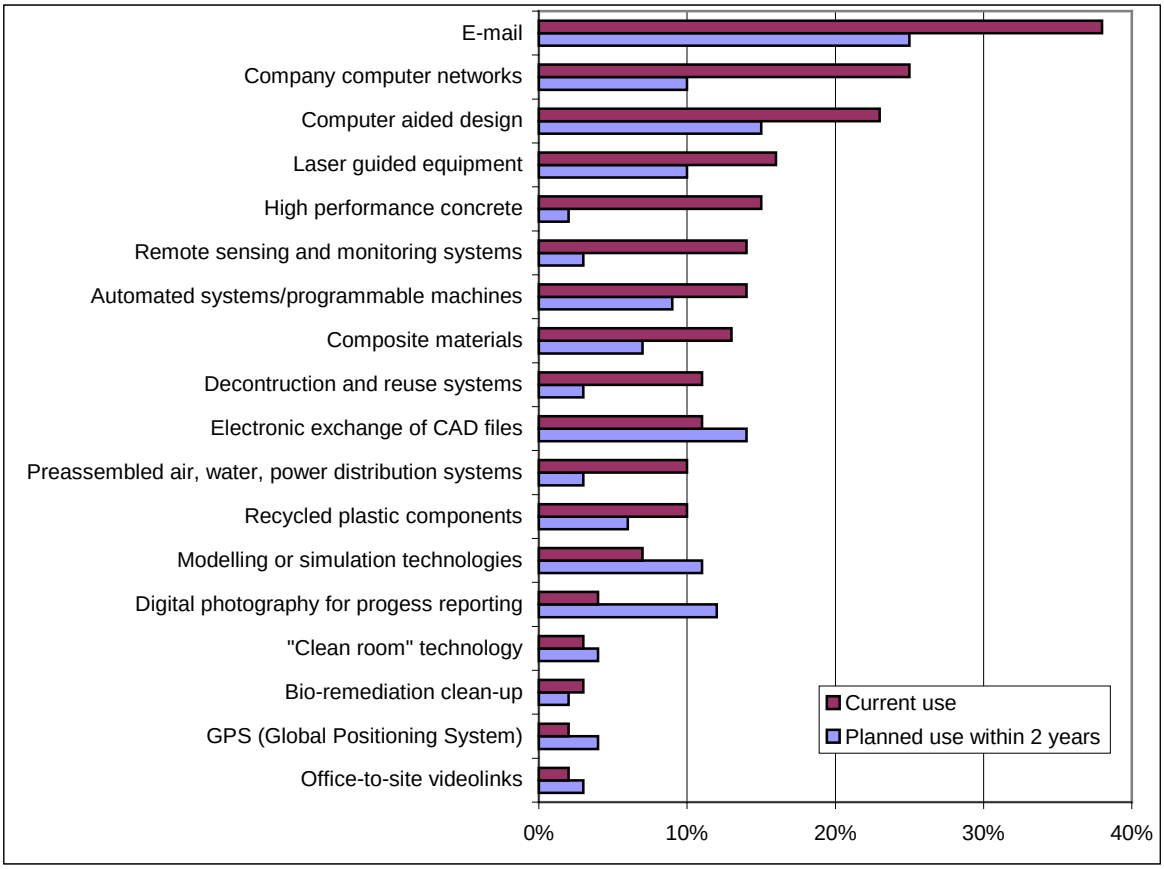


Of all the technologies surveyed, three computer related technologies had the highest percentage of use: e-mail (38%), company computer networks (25%) and computer aided design (CAD) (23%).

Planned use of technologies within two years is also highest for a number of computer related technologies: e-mail (25%), computer-aided design (CAD) (15%), electronic exchange of CAD files (14%) and digital photography for progress (12%).

The relatively higher percentage of use and planned use of communication technologies and design technologies can be explained, in part, because all businesses in construction could potentially use these technologies. Other types of technologies, for example, advanced systems, have the potential to be used only by certain industries.

Figure 6
Percentage of Businesses Indicating Use or Planned Use of Advanced Technologies Within Two Years, All Industries



With only two exceptions (preassembled air, water, power distribution systems and deconstruction and reuse systems), the larger the business the more likely it is to use advanced technologies. In the case of computer-related technologies, the contrast between small and large businesses is striking. E-mail use in large businesses is more than three times that of the small businesses. Use of company networks is four times that of small businesses. The use of electronic exchange of CAD files by large businesses is six times that of small businesses.

Table 5
Percentage of Businesses Indicating Current Use of Technologies, by Revenue Size, All Industries

	Small	Medium	Large	All
Communication Technologies				
E-mail	33%	59%	77%	38%
Digital photography for progress reporting	2%	12%	19%	4%
Office-to-site video links	2%	4%	5%	2%
Company computer networks	19%	50%	79%	25%
On-Site Plant and Equipment				
Laser guided equipment	14%	28%	39%	16%
Automated systems and programmable machines	13%	20%	26%	14%
GPS (Global Positioning System)	2%	5%	7%	2%
Materials				
High performance concrete	14%	19%	39%	15%
Composite materials	12%	20%	37%	13%
Recycled plastic components	10%	12%	23%	10%
Advanced Systems				
Remote sensing and monitoring systems	13%	19%	25%	14%
Bio-remediation clean-up	3%	5%	11%	3%
Preassembled air, water, power distribution systems	10%	7%	16%	10%
"Clean room" technology	3%	3%	9%	3%
Deconstruction and reuse systems	12%	7%	15%	11%
Design Technologies				
Computer aided design	21%	34%	55%	23%
Modelling or simulation technologies	7%	9%	18%	7%
Electronic exchange of CAD files	8%	24%	42%	11%

There are particularly high rates of planned use of communication technologies and design technologies by businesses of all revenue sizes. In particular, 25% of businesses indicated planned use of e-mail, 15% indicated planned use of computer aided design, and 14% indicated planned use of electronic exchange of CAD files.

Table 6
Percentage of Industries Indicating Planned Use of Technologies Within Two Years, by Revenue Size, All Industries

	Small	Medium	Large	All
Communication Technologies				
E-mail	25%	24%	18%	25%
Digital photography for progress reporting	11%	18%	20%	12%
Office-to-site video links	1%	9%	7%	3%
Company computer networks	9%	14%	13%	10%
On-Site Plant and Equipment				
Laser guided equipment	11%	3%	6%	10%
Automated systems and programmable machines	9%	7%	10%	9%
GPS (Global Positioning System)	3%	8%	7%	4%
Materials				
High performance concrete	1%	7%	3%	2%
Composite materials	7%	7%	4%	7%
Recycled plastic components	6%	5%	9%	6%
Advanced Systems				
Remote sensing and monitoring systems	3%	4%	11%	3%
Bio-remediation clean-up	2%	2%	6%	2%
Preassembled air, water, power distribution systems	3%	5%	9%	3%
"Clean room" technology	4%	1%	5%	4%
Deconstruction and reuse systems	3%	2%	8%	3%
Design Technologies				
Computer aided design	15%	14%	10%	15%
Modelling or simulation technologies	10%	12%	14%	11%
Electronic exchange of CAD files	14%	16%	18%	14%

The use of advanced technologies varies considerably from industry to industry (Annex 1, Table 4). "Engineering construction" has the highest percentage of firms using at least one technology in the categories of communications, on-site plant and equipment, and design technologies. "Non-residential building construction" has the highest percentage of businesses using at least materials technology and "Electrical Work" has the highest percentage of businesses using at least one systems technology.

Among the general contractors, the percentage of use of various technologies above the average for manufacturing is very high for "Engineering Construction" (15 of 18 technologies) and for "Non-Residential Building Construction" (13 of the 18 technologies) (Annex 1, Table 4). This contrasts with only 2 of the technologies that are above the average percent of use for "Residential Construction".

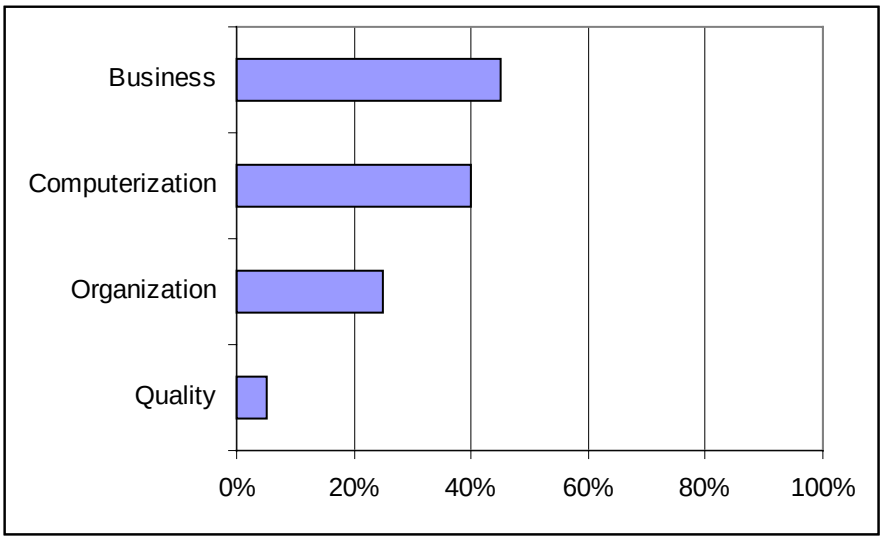
Among the specialty trades, the largest number of technologies over the manufacturing average percentage of use are found in "Electrical Installation" (12 of 18 technologies) and "Equipment Installation" (8 of 18 technologies).

5. Advanced Practices

Businesses were asked to identify advanced practices they are currently using and, if they were not currently using the advanced practice, to indicate whether they were planning to use it within two years. Questions on four types of advanced practices were asked: computerization, quality, organization and business practices. Definitions of individual advanced practices are found in the questionnaire in Annex 3.

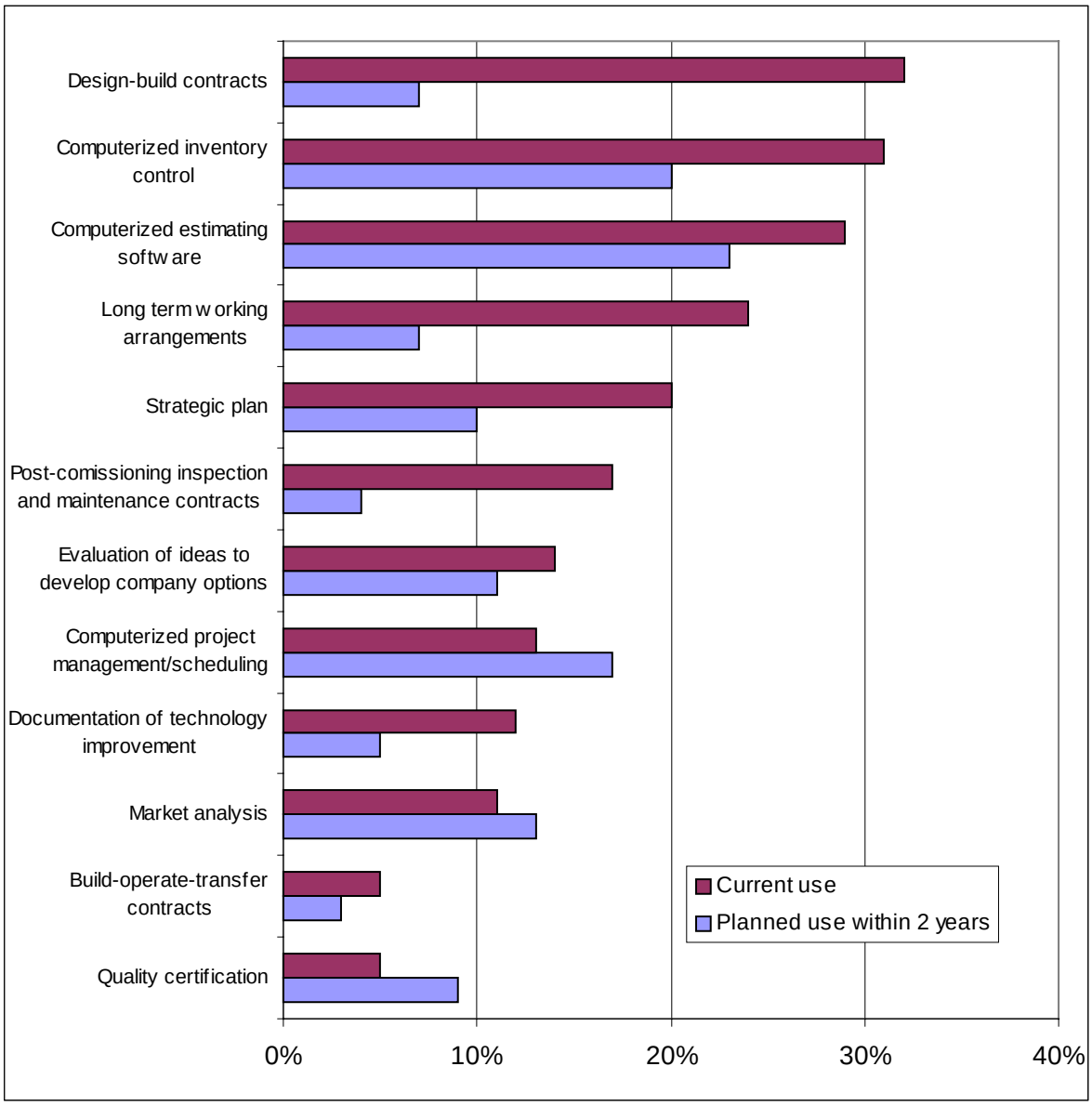
Of the four of categories of advanced practices, 4 of 10 businesses used at least one practices in communication and at least one business practice, 1 in 4 used at least one organizational practice. Only 5% used the one quality practice that was listed.

Figure 7
Percentage of Businesses Using at Least One Practice in Categories of Practices, All Industries



The three advanced practices with the largest percentage of business using them, each with appropriately one third of businesses using them are: design-build contracts, computerized inventory control and computerized estimating software. Planned use of the last two of these practices for the next 2 years is the highest among all practices (at 20% and 23% respectively). Planned use of design-build contracts is relatively low at 7%. The two practices with the lowest percentage of users are quality certification and build-operate-transfer at 5% of businesses. There are three practices where the percentage of planned use exceeds current use: computerized project management/scheduling systems, quality certification, and written market analysis report to evaluate needs/opportunities.

Figure 8
Percentage of Businesses Indicating Current Use or Planned Use of PracticesWithin Two Years, All Industries



In all cases with the exception of one, the percentage of small businesses using advanced practices is lower than the percentage of medium businesses and the percentage of medium businesses is lower that the percentage of larger business. The exception is the written documentation of technological improvement in the business where medium sized businesses have a lower percentage than both small and large businesses.

The contrast between the use of advanced practices among small and large businesses is striking. In all cases, with the exception of written documentation of technological improvements, more than twice as many larger than small businesses use each of the advanced practices. In the case

of computerized project management/scheduling systems, four times as many large than small businesses use these practices.

Table 7
Percentage of Businesses Indicating Current Use of Practices, by Revenue Size, All Industries

	Small	Medium	Large	All
Computerization				
Computerized project management/scheduling systems	9%	32%	39%	13%
Computerized estimating software	25%	47%	71%	29%
Computerized inventory control	27%	50%	71%	31%
Quality Practices				
Quality certification	3%	12%	23%	5%
Organization Practices				
Written market analysis report to evaluate needs/opportunities	9%	19%	26%	11%
Written documentation of technological improvement in firm	12%	9%	20%	12%
Written evaluation of new ideas to develop company options	14%	13%	31%	14%
Written strategic plan	19%	24%	43%	20%
Business Practices				
Design-build contracts	29%	44%	65%	32%
Build-operate-transfer (BOT) contracts	5%	7%	13%	5%
Post-commissioning inspection or maintenance contracts	15%	27%	32%	17%
Long term working arrangements with other businesses to work on joint projects	21%	34%	44%	24%

The percentage of businesses planning on using computerization practices, in general, is relatively similar regardless of the size of the business. For the other technologies, in general, the larger the business the larger percent that have it has plans to use the advanced practices. The exception to this is the use of design-build by larger businesses where planned use is less than that of medium and small businesses.

Table 8
Percentage of Businesses Indicating Planned Use of Practices Within Two Years, by Revenue Size, All Industries

	Small	Medium	Large	All
Computerization				
Computerized project management/scheduling systems	17%	15%	17%	17%
Computerized estimating software	23%	21%	19%	23%
Computerized inventory control	19%	23%	14%	20%
Quality Practices				
Quality certification	8%	13%	18%	9%
Organization Practices				
Written market analysis report to evaluate needs/opportunities	12%	16%	16%	13%
Written documentation of technological improvement in firm	4%	10%	11%	5%
Written evaluation of new ideas to develop company options	10%	17%	18%	11%
Written strategic plan	8%	19%	15%	10%
Business Practices				
Design-build contracts	7%	8%	4%	7%
Build-operate-transfer (BOT) contracts	3%	3%	11%	3%
Post-commissioning inspection or maintenance contracts	4%	8%	8%	4%
Long term working arrangements with other businesses to work on joint projects	7%	7%	15%	7%

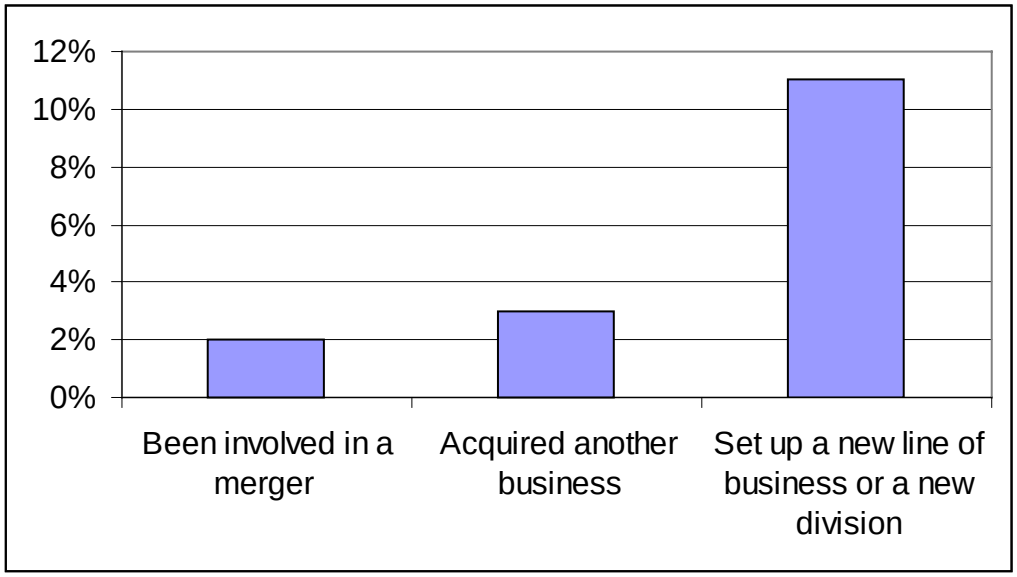
Concerning the use of advanced practices by general contractors, the findings are similar to the use of advanced technologies (Annex 2, Table 7). Non-residential and Engineering industries, for the most part, have higher percentages of use than the average for the construction than does Residential in computerization, quality and business practices. For organizational practices, all three general contractor industries have percentages of uses that are less the construction industry average. The use of formalised organizational processes are highest in the two specialty trades of Building Interior Work and Electrical Work.

In terms of planned use of advanced practices, Equipment Installation has planned use percentages that are higher than the construction industry overall for 11 of the 12 practices. (Annex 2, Table 8)

6. Mergers, Acquisitions and Expansions

Mergers, acquisitions and expansions are important components of business strategy. Businesses were asked to indicate whether they were involved in any of these three types of business activities in the previous three years. A relatively low percentage of businesses were involved in mergers (2%) and acquiring another business (3%). One in ten businesses set up a new line of business or a new division during the period
1997-1999.

Figure 9
Percentage of Businesses Indicating Involvement in Mergers, Acquisitions and Expansions During the Period 1997-1999, All Industries



The larger the business the more likely it is to be involved in mergers, acquisitions and expansions. Large businesses were particularly active during the three year period surveyed, with one in five businesses acquiring another business and more than one in three setting up a new line of business or a new division.

Table 9
Percentage of Businesses Indicating Involvement in Mergers, Acquisitions and Expansions During the Period 1997-1999, by Revenue Size, All Industries

	Small	Medium	Large	All
Been involved in a merger	1%	5%	6%	2%
Acquired another business	2%	5%	19%	3%
Set up a new line of business or a new division	8%	20%	36%	11%

The percentage of businesses with mergers in all construction industries are relatively similar (under 2%) with the exception of Site preparation work where 6% of businesses were involved. Acquisitions of businesses were particularly high for businesses in Building Equipment Installation. Setting up new divisions and lines of business was more prevalent in Building Equipment Installation, Roofing and Related Work, and Non-Residential Construction.

Table 10
Percentage of Businesses Indicating Involvement in Mergers, Acquisitions and Expansions During the Period 1997-1999, by Industry

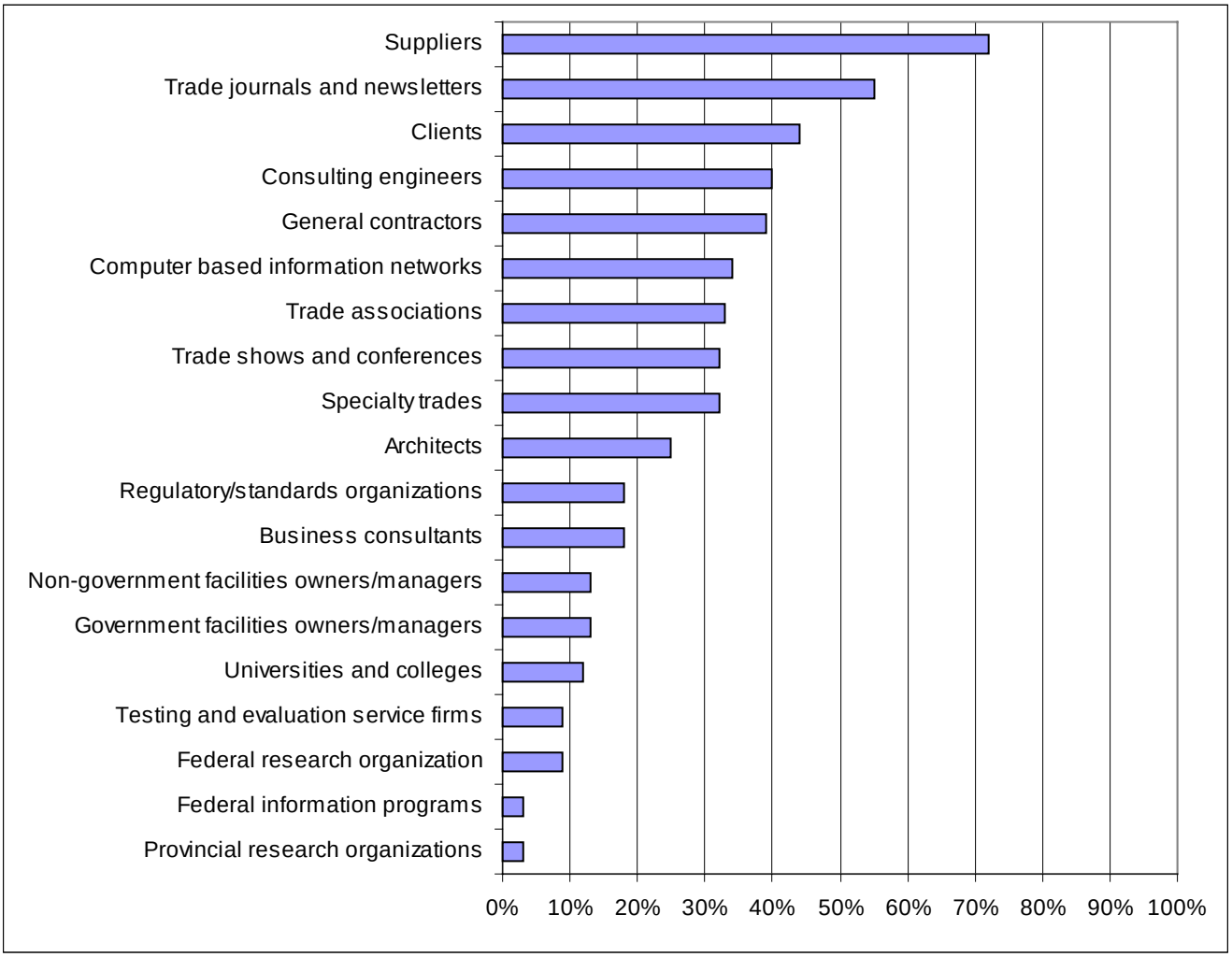
	Merger	Acquisition	New division/line of business
All Industries	2%	3%	11%
Residential Construction	2%	1%	6%
Non-Residential Construction	2%	8%	18%
Engineering Construction	1%	3%	11%
Site Preparation Work	6%	0%	11%
Building Structure Work	1%	2%	9%
Exterior Finishing Work	0%	4%	6%
Roofing and Related Work	0%	2%	21%*
Building Interior Finishing Work	2%	1%	7%
Building Equipment Installation	2%	13%	22%
Electrical Work	0%	4%	10%
Plumbing, Heating and Air-Conditioning Installation	2%	3%	11%
Other Special Trade Contracting	2%	5%	13%

***** An asterisk (*) in the table indicates that the data has a "C" reliability and is "good to poor" reliability. This data should be used with caution. See p.14 for detail.

7. Sources of Information on Advanced Technologies and Practices

Businesses were asked to indicate their sources of information on advanced technologies and practices. Suppliers of materials, supplies, machinery and equipment are the source of information for the largest percentage of businesses with three quarters of the businesses indicating this source. Trade journals and newsletters were the source of information for one half of the businesses, followed by clients which were the source of information for 44% of businesses. Consulting engineers and general contractors were the source of information for 4 of 10 of the businesses.

Figure 10
Percentage of Businesses Indicating Sources of Information on Advanced Technology and Advanced Technologies, All Industries



In general, large businesses indicate higher percentages for all sources of information than small and medium businesses. There are several exceptions to this however. Small and medium businesses have higher percentages of general contractors as sources of information. Small businesses cite non-government owners and managers with the same percentage as larger ones.

Three public organizations (government facilities owners and managers, universities and colleges, and federal research organizations) have higher percentages for small businesses than for the large businesses. In the case of the federal research organizations, twice as many small businesses indicate it as a source as do large businesses.

Table 11
Percentage of Businesses Indicating Sources of Information on Advanced Technology and Advanced Technologies, by Revenue Size, All Industries

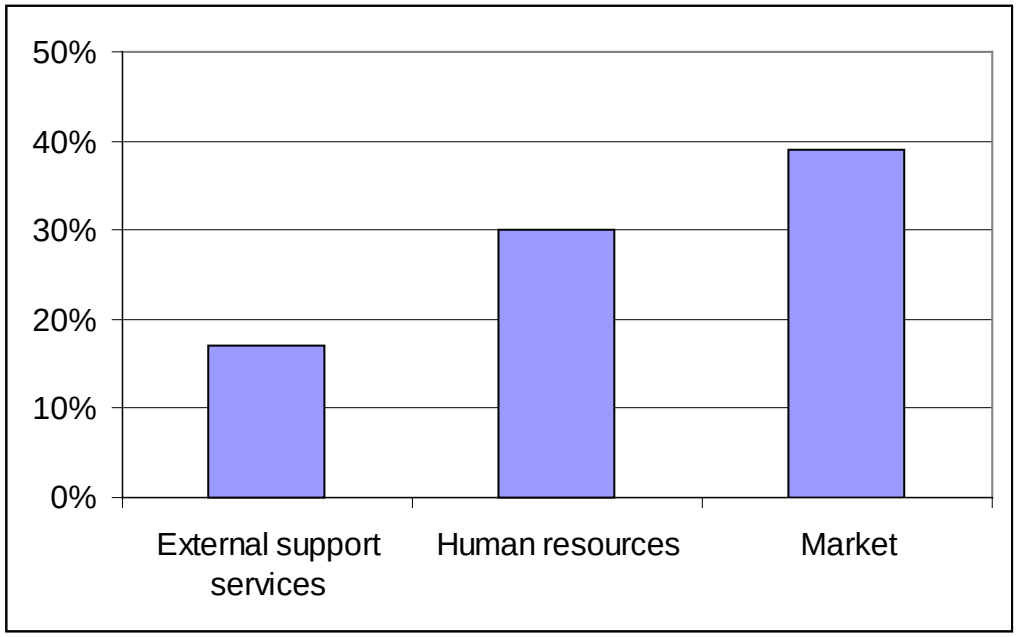
	Small	Medium	Large	All
Suppliers	70%	80%	81%	72%
Trade journals and newsletters	52%	71%	82%	55%
Clients	42%	54%	60%	44%
Consulting engineers	37%	53%	64%	40%
General contractors	40%	38%	35%	39%
Computer based information networks	32%	43%	62%	34%
Trade associations	29%	48%	70%	33%
Trade shows and conferences	28%	53%	64%	32%
Specialty trades	31%*	32%	42%	32%
Architects	37%	36%	47%	25%
Regulatory and standards organizations	18%	17%	35%	18%
Business consultants	18%	19%	36%	18%
Non-government facilities owners and managers	13%	11%	13%	13%
Government facilities owners and managers	13%	9%	9%	13%
Universities and colleges	13%	9%	12%	12%
Testing and evaluation service firms	9%	11%	26%	9%
Federal research organization	10%	5%	5%	9%
Federal information programs	2%	8%	7%	3%
Provincial research organizations	3%	6%	8%	3%

Different industries use different sources of information (Annex 2, Table 9). For example, Non-residential construction has a particularly high percentage of businesses using five of the sources: clients, suppliers, specialty trades, consulting engineers, and architects. On the other hand, a high percentage of Building Interiors businesses make use of computer based networks, non-government facilities owners or managers, federal research organizations, universities and colleges, and business consultants.

8. Obstacles

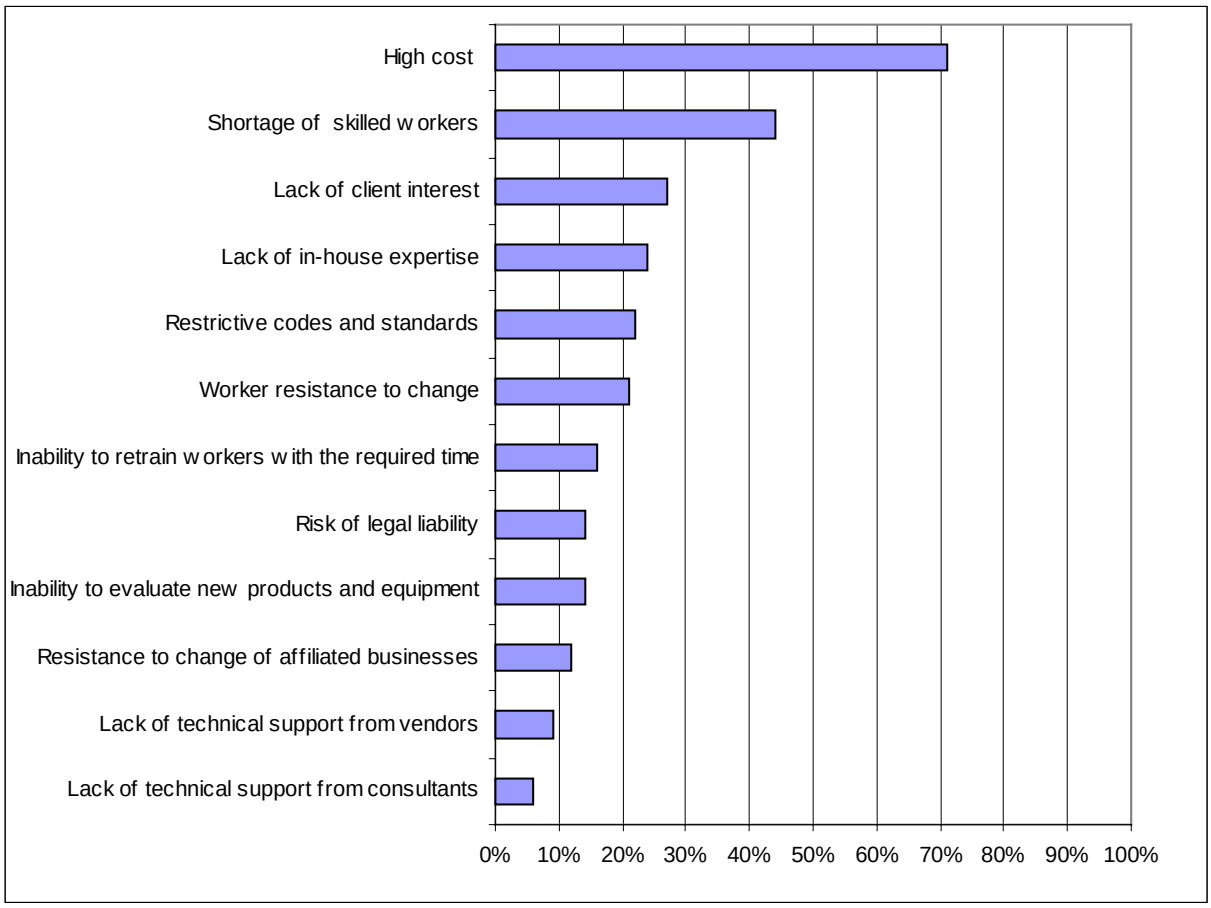
Businesses were asked whether or not a number of factors were major obstacles to using new and improved building products, building systems and construction equipment. The possible obstacles were classified in three categories: market obstacles, human resource obstacles and external support services obstacles. 40% of the businesses identified at least one of the market obstacles, followed by one third of the businesses that identified at least one of the human resource obstacles.

Figure 11
Percentage of Businesses Indicating Obstacles to Using New and Improved Building Products, Systems and Equipment, by Type of Obstacle, All Industries



The high cost of products, systems and equipment was the greatest obstacle as perceived by 70% of businesses. Shortage of workers was the second major obstacle, as perceived by more than 40% of businesses.

Figure 12
Percentage of Businesses Indicating Obstacles to Using New and Improved Building Products, Systems and Equipment, All Industries



Five of the twelve obstacles are related to size in as much as the larger the firm the more likely it is to indicate that these factors are obstacles. These obstacles include: risk of legal liability, restrictive codes and standards, worker resistance to change, lack of technical support from vendors, and lack of technical support from consultants. Concerning the cost of products, systems and equipment, two thirds of medium sized firms consider this to be a major obstacle which is less than the percentage of small and large businesses which consider it to be a major obstacle. Similarly with the shortage of skilled workers, a lower percentage of medium size businesses perceive this to be a major obstacle than do small or large businesses.

Table 12
Percentage of Businesses Indicating Obstacles to Using New and Improved Building Products, Systems and Equipment, by Revenue Size, All Industries

	Small	Medium	Large	All
Market Obstacles				
High cost	73%	65%	69%	71%
Lack of client interest	27%	24%	32%	27%
Resistance to change of affiliated businesses	12%	12%	11%	12%
Risk of legal liability	13%	18%	20%	14%
Restrictive codes and standards	20%	29%	36%	22%
Human Resource Obstacles				
Shortage of skilled workers	45%	38%	44%	44%
Lack of in-house expertise	25%	23%	25%	24%
Inability to retrain workers with the required time	16%	21%	18%	16%
Worker resistance to change	20%	26%	32%	21%
External Support Obstacles				
Lack of technical support from vendors	8%	12%	16%	9%
Lack of technical support from consultants	5%	7%	13%	6%
Inability to evaluate new products and equipment	14%	14%	21%	14%

There is considerable variation between industries on how businesses perceive obstacles to using new and improved building products, building systems and construction equipment (Annex 2, Table 10). Non-residential has the highest percentage of businesses perceiving obstacles in six of the categories of obstacles, including areas indicating lack of expertise: inability to train workers within the required time, lack of technical support from consultants, and inability to evaluate new products and equipment. Building equipment installation had the highest percentage of businesses indicating risk of legal liability and restrictive codes and standards. The highest percentage of businesses indicating that shortage of skilled workers is an issue in Residential Building Construction.

Annex 1: Industry Stratification

The following table contains the industry strata that were used in the sample selection process. They are based on the 1997 North American Industry Classification System (NAICS) codes.

The following distinction is made in the NAICS system between "Prime Contracting" and "Trade Contracting" which corresponds to the terms used in industry to the distinction between "General Contractors" and "Specialty Trades".

- **Prime Contracting** (all industries beginning with 231): This subsector comprises establishments engaged in constructing complete works, with buildings or engineering works. Projects undertaken by these establishments typically have several components, varying proportions of which can be subcontracted to trade contractors or done by the establishment's own labour force.

- **Trade Contracting** (all industries beginning with 232): This subsector comprises establishments engaged in one aspect common to different structures, requiring specialized skills or equipment. They are known as trade contractors, and are classified by the specific component they contribute to the total structure or work. Trade contractors normally supply their specialized service under contract to a general contractor.

PRIME CONTRACTING	
2311	**Land Subdivision and Land Development:** establishments primarily engaged in the acquisition, assembly , subdivision into lots and servicing of raw land for subsequent sale to builders.
23121	**Building Construction- Residential:** establishments primarily engaged in construction residential buildings, such as houses, garden homes, cottages, apartments and townhouses. Establishments primarily engaged in erecting prefabricated homes are also included.
23122	**Building Construction- Non-Residential:** establishments primarily engaged in constructing commercial, institutional and industrial buildings. Important types of commercial and institutional buildings are offices, hotels, restaurants, arenas, churches and penitentiaries. Important types of industrial buildings are factories and heavy industrial plants for production of such products as aluminium and cement. The erection of prefabricated commercial or institutional buildings are also included.
2313	**Engineering Construction:** establishments primarily engaged in construction projects other than buildings. Engineering works include dams; non-building industrial works such as refineries; highways, roads and streets; bridges; sewers; power and communication transmission lines; and similar structures and works.
2314	**Construction Management:** establishments primarily in managing a construction project for a fee. These establishments provide day-to-day co-ordination, supervision and management of a construction site. These activities would otherwise be performed by a general contractor.

TRADE CONTRACTING	
2321	**Site Preparation Work:** establishments primarily engaged in site preparation activities, such as agricultural land clearing; land drainage and reclamation; demolition of buildings and other structures, excavating and grading; cutting of rights-of-way; pile driving; concrete breaking for roads; water well drilling; septic tank installation; and house moving. Establishments primarily engaged in equipment rental with operator (except cranes) are also included.
2322	**Building Structure Work:** establishments primarily engaged in erecting the basis structure of buildings by pouring concrete; framing with lumber; welding, bolting or tying steel; and placing percast or pre-stressed concrete members. Crane rental services with operator are also included because they support the erection process.
23233	**Roofing and Related Work:** This industry comprises establishment primarily engaged in installing shingles, built-up roofing and other roofing materials; and associated work, such as installing flashing and eavestroughs.
2323 (minus 23233)	**Building Exterior Finishing Work:** establishments engaged in closing-in and finishing the exterior structure of buildings, includes masonry work; glass and glazing work; metallic and other siding work (does not include roofing).
2324	**Building Interior Finishing Work:** establishments engaged in finishing building interiors. This work generally involved covering the interior structure with various materials, including drywall and plaster works; terrazzo and tile work; carpet and resilient flooring work; insulation work; building painting and paperhanging work; and finish carpentry and wood flooring work.
23251	**Electrical Work:** establishments primarily engaged in installing and repairing electrical and communication wiring system, including panel boxes, wires, outlets, lights and appliances. The installation and repair of environmental controls, security and fire detection devices are also included.
23252	**Plumbing, Heating and Air-Conditioning Installation:** establishments primarily engaged in installing primary water piping systems, plumbing fixtures, secondary piping systems for wet heating, natural gas pipe fitting for dry heating, and central air-conditioning equipment. The installation of sheet metal duct work is included.
2325 (minus 23251 & 23251)	**Building Equipment Installation:** establishments primarily engaged in installing or erecting building equipment, including automatic sprinkler installation, commercial refrigeration installation, and elevator and escalator installation. (does not include electrical work and plumbing, heating and air-conditioning installation).
2329	**Other Special Trade Contracting:** establishments primarily, not classified to any other industry group, primarily engaged in specialized trades, including fencing and interlocking stone contracting, residential and commercial paving contracting, as well as others.

Annex 2: Tables

The reliability of the data has been assessed using the following convention:

Code	Rating	Standard Error
A	Very good	<2.5%
B	Good	>2.5% and <7.5%
C	Good to poor- use with caution	>7.5 and<15%
D	Very poor- may not be acceptable	≥15%

In the tables in this annex estimates with a rating code of "C" are shaded. Estimates with a rating of "D" have not been presented and have been replaced by "…". All other estimates in the tables are of "A" or "B" rating.

Two of the industries that were surveyed, "Land subdivision and land development" (2311) and "Construction management" (2314) had generally poor or very poor reliability. The estimates for these two industries are not presented separately in the tables, however, they are included as part of the total estimates of the construction sector.

Table 1: Business Environment, Percentage of Businesses Agreeing with Statement, by Industry

	All Industries	Residential Construct.	Non-Resident. Construct.	Engineering Construct.	Site Preparation	Building Structure	Building Exterior
My clients' needs are easy to predict	49%	…	44%	40%	39%	52%	45%
My clients can easily find a substitute for my services	61%	77%	43%	52%	59%	62%	53%
My competitors' actions are easy to predict	31%	…	22%	42%	40%	24%	37%
My business can easily substitute among suppliers	52%	67%	48%	68%	40%	49%	53%
The arrival of new competitors is a constant threat	61%	69%	43%	50%	66%	61%	63%
Materials and supplies quickly become obsolete	15%	12%	15%	10%	23%	12%	11%
Technologies in the office are changing rapidly	56%	27%	61%	47%	53%	60%	54%
Technologies on the construction/building site are changing rapidly	44%	…	43%	26%	52%	27%	33%

	Roofing	Building Interior	Equipment Installation	Electrical Work	Plumbing, Heat. & Air-Condition.	Other
My clients' needs are easy to predict	57%	64%	31%	45%	49%	66%
My clients can easily find a substitute for my services	91%	73%	48%	38%	53%	35%
My competitors' actions are easy to predict	…	18%	32%	34%	26%	49%
My business can easily substitute among suppliers	…	47%	31%	36%	46%	59%
The arrival of new competitors is a constant threat	76%	71%	54%	57%	54%	40%
Materials and supplies quickly become obsolete	17%	20%	13%	22%	10%	2%
Technologies in the office are changing rapidly	72%	69%	73%	71%	51%	60%
Technologies on the construction/building site are changing rapidly	…	52%	56%	47%	43%	28%

Table 2: Factors for Business Success, by Industry (1)

	All Industries	Residential Construct.	Non-Resid. Construct.	Engineering Construction	Site Preparation	Building Structures	Building Exterior
Business strategy							
Developing unique expertise or a unique market	52%	38%	47%	49%	40%	26%	44%
Delivering products or services which reduce the client's operating costs	53%	25%	42%	77%	53%	45%	37%
Seeking business outside of your present geographical region of activity	21%	10%	30%	18%	17%	21%	13%
Increasing your market share	53%	31%	49%	50%	63%	28%	50%
Building and enhancing relationships with existing clients	87%	86%	90%	84%	81%	70%	81%
Attracting new clients	81%	83%	83%	67%	80%	55%	68%
Providing a broader range of services to your clients	54%	62%	50%	41%	45%	29%	42%
Ensuring employees are aware of business issues	60%	63%	52%	61%	61%	38%	44%
Human Resources							
Encouraging and regarding your employees to seek out technological improvements	42%	24%	37%	56%	32%	16%	36%
Encouraging and rewarding your employees to seek out organizational improvements	50%	…	49%	71%	32%	25%	44%
Providing or supporting training programs for employees	49%	…	44%	75%	39%	25%	40%
Hiring new graduates from colleges and universities	11%	3%	24%	33%	10%	5%	6%
Hiring experienced employees	69%	82%	76%	87%	65%	53%	80%
Participating in apprenticeship programs	34%	18%	55%	51%	6%	28%	48%
Using teams which bring together people with different skills	33%	10%	34%	47%	19%	17%	20%
Technology							
Introducing new user-friendly technologies	41%	19%	28%	37%	16%	18%	30%
Investing in research and development	16%	4%	5%	13%	9%	5%	16%
Protecting intellectual properties (patents, trademarks, copyrights, etc.)	14%	2%	10%	19%	20%	3%	24%
Enhancing your technical capabilities	50%	28%	46%	68%	42%	24%	29%
Participating in the development of industry standards and practices	42%	24%	30%	32%	40%	31%	23%

Table 2: Factors for Business Success, by Industry (2)

		Roofing	Building Interior	Equipment Installation	Electrical	Plumb., Heat. & Air-Condit.	Other
Business strategy							
	Developing unique expertise or a unique market	…	68%	66%	64%	56%	64%
	Delivering products or services which reduce the client's operating costs	…	68%	85%	77%	70%	41%
	Seeking business outside of your present geographical region of activity	18%	44%	33%	23%	8%	27%
	Increasing your market share	…	68%	74%	54%	63%	57%
	Building and enhancing relationships with existing clients	66%	95%	97%	95%	90%	81%
	Attracting new clients	98%	86%	91%	88%	74%	90%
	Providing a broader range of services to your clients	33%	71%	74%	54%	59%	58%
	Ensuring employees are aware of business issues	58%	69%	83%	57%	57%	61%
Human Resources							
	Encouraging and regarding your employees to seek out technological improvements	41%	61%	57%	61%	41%	53%
	Encouraging and rewarding your employees to seek out organizational improvements	54%	62%	68%	66%	45%	44%
	Providing or supporting training programs for employees	…	57%	78%	54%	57%	34%
	Hiring new graduates from colleges and universities	9%	2%	37%	26%	11%	5%
	Hiring experienced employees	…	49%	79%	74%	66%	85%
	Participating in apprenticeship programs	24%	20%	71%	72%	49%	30%
	Using teams which bring together people with different skills	25%	49%	60%	53%	35%	41%
Technology							
	Introducing new user-friendly technologies	34%	63%	57%	63%	55%	41%
	Investing in research and development	9%	40%	38%	27%	5%	23%
	Protecting intellectual properties (patents, trademarks, copyrights, etc.)	13%	10%	17%	21%	25%	16%
	Enhancing your technical capabilities	41%	63%	77%	75%	65%	62%
	Participating in the development of industry standards and practices	…	57%	66%	51%	46%	56%

Table 3: Percentage of Businesses Using at Least One Advanced Technology, by Industry

	Communicat.	On-site plant and equipment	Materials	Systems	Design
Total, Construction Industry	46%	26%	22%	25%	25%
Residential Building Construction	28%	20%	18%	15%	8%
Non-Residential Building Construction	59%	29%	35%	22%	33%
Engineering Construction	72%	58%	31%	35%	52%
Site Preparation Work	40%	39%	32%	17%	10%
Building Structure Work	24%	21%	20%	9%	9%
Building Exterior Finishing Work	25%	6%	10%	5%	6%
Roofing and Related Work	20%	12%	…	14%	…
Building Interior Finishing Work	58%	13%	13%	11%	40%
Building Equipment Installation	64%	23%	7%	34%	32%
Electrical Work	66%	41%	22%	62%	32%
Plumbing, Heating and Air-Conditioning Installation	44%	20%	10%	38%	21%
Other Special Trade Contracting	54%	33%	18%	17%	10%

Table 4: Use of Advanced Technologies, by Industry (1)

	All Industries	Residential	Non-Residential	Engineering	Site Preparation	Building Structure	Building Exterior
Communications							
E-mail	38%	23%	50%	64%	33%	22%	16%
Digital photography for progress reporting	4%	2%	19%	12%	1%	1%	7%
Office-to-site video links or video conferencing	2%	0%	6%	1%	5%	0%	0%
Company computer networks (LAN or WAN)	25%	12%	32%	39%	9%	7%	8%
On-site plant and equipment							
Laser-guided equipment	16%	19%	23%	23%	37%	18%	5%
Automated systems and programmable machines	14%	3%	12%	46%	4%	7%	1%
GPS (Global Positioning System)	2%	0%	2%	5%	6%	6%	0%
Materials							
High performance concrete	15%	16%	28%	26%	25%	19%	4%
Composite materials (e.g. fiber reinforced plastics)	13%	8%	20%	16%	20%	13%	6%
Recycled plastic components	10%	2%	11%	7%	9%	8%	3%
Systems							
Remote sensing and monitoring systems (e.g. "smart" detection systems)	14%	2%	10%	25%	5%	5%	2%
Bio-remediation clean-up	3%	0%	4%	8%	4%	1%	1%
Preassembled air, water, power distribution systems (e.g. "drop-in" systems)	10%	2%	10%	27%	3%	4%	0%
"Clean room" technology	3%	2%	4%	2%	1%	4%	0%
Deconstruction and reuse systems	11%	11%	12%	25%	13%	6%	1%
Design							
Computer aided design	23%	7%	31%	48%	10%	9%	5%
Modeling or simulation technologies	7%	3%	9%	22%	1%	1%	1%
Electronic exchange of CAD files	11%	5%	12%	20%	2%	2%	3%

Table 4: Use of Advanced Technologies, by Industry (2)

	Roofing	Building Interior	Equipment Installation	Electrical	Plumb., Heat & Air-Cond.	Other
Communications						
E-mail	18%	55%	59%	53%	28%	53%
Digital photography for progress reporting	7%	0%	6%	3%	2%	4%
Office-to-site video links or video conferencing	5%	0%	2%	2%	1%	0%
Company computer networks (LAN or WAN)	14%	40%	28%	33%	24%	11%
On-site plant and equipment						
Laser-guided equipment	1%	12%	5%	3%	3%	29%
Automated systems and programmable machines	11%	5%	21%	40%	18%	7%
GPS (Global Positioning System)	0%	0%	2%	1%	0%	0%
Materials						
High performance concrete	0%	5%	1%	11%	4%	9%
Composite materials (e.g. fiber reinforced plastics)	…	8%	6%	16%	7%	12%
Recycled plastic components	9%	6%	3%	20%	5%	8%
Systems						
Remote sensing and monitoring systems (e.g. "smart" detection systems)	9%	2%	28%	58%	17%	15%
Bio-remediation clean-up	2%	1%	1%	11%	3%	1%
Preassembled air, water, power distribution systems (e.g. "drop-in" systems)	0%	3%	12%	18%	27%	1%
"Clean room" technology	0%	1%	1%	11%	7%	0%
Deconstruction and reuse systems	3%	8%	4%	5%	16%	4%
Design						
Computer aided design	8%	39%	30%	29%	21%	6%
Modeling or simulation technologies	…	0%	3%	13%	1%	2%
Electronic exchange of CAD files	…	3%	16%	21%	3%	5%

Table 5: Planned Use of Advanced Technologies (1)

		All Industries	Residential	Non-Residential	Engineering Construction	Site Preparation	Building Structure	Building Exterior
Communications								
	E-mail	25%	16%	34%	23%	21%	12%	50%
	Digital photography for progress reporting	12%	11%	16%	17%	21%	5%	4%
	Office-to-site video links or video conferencing	3%	4%	10%	4%	0%	0%	3%
	Company computer networks (LAN or WAN)	10%	8%	13%	5%	7%	4%	4%
On-site plant and equipment								
	Laser-guided equipment	10%	2%	11%	12%	8%	2%	6%
	Automated systems and programmable machines	9%	1%	11%	5%	2%	1%	6%
	GPS (Global Positioning System)	4%	3%	5%	8%	11%	1%	3%
Materials								
	High performance concrete	2%	3%	3%	6%	1%	6%	6%
	Composite materials (e.g. fiber reinforced plastics)	7%	10%	31%	7%	1%	6%	2%
	Recycled plastic components	6%	8%	33%	7%	2%	5%	4%
Systems								
	Remote sensing and monitoring systems (e.g. "smart" detection systems)	3%	1%	8%	8%	1%	0%	0%
	Bio-remediation clean-up	2%	1%	1%	3%	1%	0%	0%
	Preassembled air, water, power distribution systems (e.g. "drop-in" systems)	3%	0%	3%	9%	7%	0%	0%
	"Clean room" technology	4%	1%	21%	1%	5%	0%	0%
	Deconstruction and reuse systems	3%	0%	26%	2%	6%	1%	1%
Design								
	Computer aided design	15%	19%	32%	17%	13%	3%	10%
	Modeling or simulation technologies	11%	4%	12%	25%	7%	1%	2%
	Electronic exchange of CAD files	14%	4%	18%	35%	6%	3%	6%

Table 5: Planned Use of Advanced Technologies (2)

	Roofing	Building Interior	Equipment Installation	Electrical Work	Plumb., Heat & Air-Condit.	Other
Communications						
E-mail	…	24%	25%	20%	27%	18%
Digital photography for progress reporting	5%	13%	19%	11%	5%	3%
Office-to-site video links or video conferencing	0%	1%	22%	0%	5%	0%
Company computer networks (LAN or WAN)	13%	5%	24%	27%	4%	10%
On-site plant and equipment						
Laser-guided equipment	0%	35%	2%	12%	1%	7%
Automated systems and programmable machines	5%	38%	4%	1%	3%	10%
GPS (Global Positioning System)	0%	2%	8%	10%	3%	1%
Materials						
High performance concrete	0%	0%	0%	1%	1%	3%
Composite materials (e.g. fiber reinforced plastics)	1%	0%	1%	12%	5%	3%
Recycled plastic components	1%	1%	2%	12%	2%	1%
Systems						
Remote sensing and monitoring systems (e.g. "smart" detection systems)	0%	2%	8%	6%	7%	2%
Bio-remediation clean-up	0%	0%	8%	10%	3%	0%
Preassembled air, water, power distribution systems (e.g. "drop-in" systems)	0%	1%	1%	13%	5%	1%
"Clean room" technology	0%	2%	8%	11%	5%	3%
Deconstruction and reuse systems	0%	1%	1%	10%	1%	1%
Design						
Computer aided design	6%	12%	20%	16%	18%	19%
Modeling or simulation technologies	2%	36%	9%	3%	1%	4%
Electronic exchange of CAD files	5%	36%	11%	19%	6%	9%

Table 6: At Least One Advanced Practice

	Computerization	Quality	Organization	Business
All Industries	40%	5%	25%	45%
Building Construction - Residential	22%	5%	10%	32%
Building Construction - Non-Residential	56%	10%	21%	54%
Engineering Construction	66%	17%	15%	60%
Site Preparation Work	17%	6%	25%	32%
Building Structure Work	16%	3%	7%	19%
Building Exterior Finishing Work	24%	1%	12%	20%
Roofing and Related Work	15%	1%	…	…
Building Interior Finishing Work	51%	1%	41%	54%
Building Equipment Installation	48%	10%	27%	63%
Electrical Work	69%	5%	31%	68%
Plumbing, Heating and Air-Conditioning Installation	41%	8%	24%	60%
Other Special Trade Contracting	24%	3%	13%	40%

Table 7: Use of Advanced Practices, by Industry (1)

	All Industries	Building Construction - Residential	Non-Residential	Eng. Construction	Site Preparation	Building Structure	Building Exterior
Computerization							
Computerized inventory control	13%	8%	18%	20%	10%	4%	7%
Computerized estimating software	29%	18%	39%	41%	12%	13%	15%
Computerized project management and/or scheduling systems	31%	16%	46%	58%	11%	8%	17%
Quality							
Quality certification (e.g. ISO 9000, R2000)	5%	5%	10%	17%	6%	3%	1%
Organization							
Written market analysis report to evaluate needs and opportunities of your business	11%	7%	7%	7%	13%	2%	5%
Written documentation of technological improvements developed by your business	12%	1%	3%	6%	7%	1%	2%
Written evaluation of new ideas in order to develop options for your business	14%	4%	8%	8%	13%	2%	9%
Written strategic plan	20%	5%	18%	13%	20%	5%	5%
Business							
Design-build contracts	32%	22%	46%	52%	16%	11%	10%
Build-operate-transfer (BOT) contracts	5%	2%	8%	21%	1%	1%	0%
Post-commissioning inspection or maintenance contracts	17%	4%	12%	40%	7%	4%	2%
Long-term working arrangements with other businesses to work together on joint projects	24%	16%	28%	50%	31%	14%	13%

Table 7: Use of Advanced Practices, by Industry (2)

	Roofing	Building Interior	Equipment Installation	Electrical Work	Pumb., Heat. & Air-Condit.	Other
Computerization						
Computerized inventory control	8%	4%	32%	21%	11%	14%
Computerized estimating software	10%	44%	33%	43%	26%	13%
Computerized project management and/or scheduling systems	5%	41%	32%	59%	22%	8%
Quality						
Quality certification (e.g. ISO 9000, R2000)	1%	1%	10%	5%	8%	3%
Organization						
Written market analysis report to evaluate needs and opportunities of your business	…	3%	5%	23%	4%	3%
Written documentation of technological improvements developed by your business	…	37%	8%	12%	9%	4%
Written evaluation of new ideas in order to develop options for your business	…	35%	10%	13%	15%	3%
Written strategic plan	6%	35%	20%	30%	15%	10%
Business						
Design-build contracts	…	41%	22%	46%	42%	17%
Build-operate-transfer (BOT) contracts	4%	0%	7%	23%	2%	0%
Post-commissioning inspection or maintenance contracts	9%	4%	43%	57%	32%	11%
Long-term working arrangements with other businesses to work together on joint projects	9%	12%	37%	38%	37%	37%

Table 8: Planned Use of Advanced Practices (1)

		All Industries	Residential	Non-Residential	Engineering Construction	Site Preparation	Building Structure	Building Exterior
Computerization								
	Computerized inventory control	17%	6%	13%	12%	15%	11%	17%
	Computerized estimating software	23%	11%	44%	23%	25%	15%	20%
	Computerized project management and/or scheduling systems	20%	13%	20%	17%	25%	15%	17%
Quality								
	Quality certification (e.g. ISO 9000, R2000)	9%	2%	18%	8%	4%	6%	12%
Organization								
	Written market analysis report to evaluate needs and opportunities of your business	13%	5%	12%	16%	7%	5%	6%
	Written documentation of technological improvements developed by your business	5%	2%	6%	13%	4%	5%	5%
	Written evaluation of new ideas in order to develop options for your business	11%	11%	15%	7%	7%	9%	5%
	Written strategic plan	10%	8%	20%	7%	8%	6%	7%
Business								
	Design-build contracts	7%	8%	30%	4%	10%	4%	4%
	Build-operate-transfer (BOT) contracts	3%	1%	6%	5%	0%	5%	2%
	Post-commissioning inspection or maintenance contracts	4%	2%	4%	5%	5%	2%	6%
	Long-term working arrangements with other businesses to work together on joint projects	7%	8%	11%	15%	1%	3%	7%

Table 8: Planned Use of Advanced Practices (2)

		Roofing	Building Interior	Equipment Installation	Electrical Work	Plumb., Heat. & Air-Condit.	Other
Computerization							
	Computerized inventory control	21%	23%	33%	24%	23%	26%
	Computerized estimating software	23%	24%	41%	23%	37%	48%
	Computerized project management and/or scheduling systems	22%	28%	43%	11%	25%	33%
Quality							
	Quality certification (e.g. ISO 9000, R2000)	5%	9%	35%	25%	7%	3%
Organization							
	Written market analysis report to evaluate needs and opportunities of your business	3%	36%	19%	3%	16%	10%
	Written documentation of technological improvements developed by your business	1%	2%	29%	16%	4%	2%
	Written evaluation of new ideas in order to develop options for your business	13%	8%	31%	15%	17%	12%
	Written strategic plan	12%	14%	23%	6%	19%	5%
Business							
	Design-build contracts	2%	3%	15%	10%	9%	1%
	Build-operate-transfer (BOT) contracts	0%	1%	12%	10%	5%	2%
	Post-commissioning inspection or maintenance contracts	10%	4%	15%	5%	5%	9%
	Long-term working arrangements with other businesses to work together on joint projects	3%	5%	17%	15%	5%	4%

Table 9: Sources of Information (1)

	All Industries	Residential	Non-Residential	Engineering Construct.	Site Preparation	Building Structure	Building Exterior
Trade shows and conferences	32%	25%	29%	42%	28%	19%	14%
Trade journals and newsletters	55%	26%	49%	85%	62%	26%	37%
Trade associations	33%	15%	38%	43%	24%	17%	37%
Computer based information networks (including internet)	34%	18%	34%	52%	23%	12%	13%
Suppliers of materials, supplies, machinery and equipment	72%	…	88%	86%	53%	45%	71%
Clients	44%	…	73%	51%	32%	19%	48%
General contractors	39%	…	58%	53%	23%	27%	54%
Specialty trades	32%	…	63%	19%	21%	19%	18%
Consulting engineers	40%	25%	68%	63%	18%	17%	27%
Architects	25%	16%	66%	15%	4%	10%	43%
Government facility owners or managers	13%	1%	6%	10%	7%	2%	1%
Non-government facility owners or managers	13%	3%	15%	11%	8%	3%	1%
Federal information programs	3%	3%	6%	5%	2%	2%	1%
Federal research organizations	9%	2%	7%	3%	6%	0%	1%
Provincial research organizations	3%	3%	4%	3%	2%	0%	1%
Universities and colleges	12%	2%	7%	7%	7%	4%	4%
Regulatory and standards organizations	18%	11%	12%	21%	15%	8%	6%
Testing and evaluation service firms	9%	7%	14%	12%	13%	4%	8%
Business consultants	18%	8%	15%	8%	14%	4%	11%

Table 9: Sources of Information (2)

	Roofing	Building Interior	Building Equipment	Electrical Work	Plumb., Heat. & Air-Condit.	Other
Trade shows and conferences	…	19%	49%	57%	56%	26%
Trade journals and newsletters	…	71%	64%	73%	78%	37%
Trade associations	26%	23%	52%	48%	61%	32%
Computer based information networks	29%	54%	37%	50%	29%	33%
Suppliers	…	85%	78%	94%	84%	55%
Clients	26%	57%	63%	65%	37%	51%
General contractors	26%	22%	33%	57%	43%	59%
Specialty trades	17%	20%	36%	46%	36%	19%
Consulting engineers	…	46%	35%	64%	41%	23%
Architects	10%	20%	13%	35%	17%	28%
Government facility owners or managers	6%	35%	11%	28%	7%	18%
Non-government facility owners or managers	16%	36%	14%	16%	6%	19%
Federal information programs	4%	1%	7%	11%	2%	1%
Federal research organizations	4%	34%	4%	12%	1%	2%
Provincial research organizations	3%	0%	4%	15%	1%	2%
Universities and colleges	7%	35%	22%	14%	10%	4%
Regulatory and standards organizations	6%	7%	33%	41%	42%	12%
Testing and evaluation service firms	2%	4%	16%	4%	13%	5%
Business consultants	9%	39%	17%	24%	15%	13%

Table 10: Obstacles, by Industry (1)

		All Industries	Residential	Non-Residential	Engineering Construction	Site Preparation	Building Structure	Building Exterior
Market								
	High cost of products, systems and equipment	71%	72%	68%	54%	57%	65%	63%
	Lack of interest by clients	27%	…	46%	13%	14%	9%	22%
	Resistance to change by businesses with which your business has joint projects	12%	…	23%	7%	7%	5%	16%
	Risk of legal liability	14%	8%	32%	20%	4%	16%	12%
	Restrictive codes and standards	22%	17%	40%	18%	30%	24%	30%
Human resources								
	Shortage of skilled workers	44%	68%	36%	33%	22%	37%	48%
	Lack of in-house expertise	24%	21%	36%	18%	10%	6%	13%
	Inability to train workers within the required time	16%	21%	25%	14%	12%	13%	20%
	Worker resistance to change	21%	…	19%	18%	10%	20%	34%
External support services								
	Lack of technical support from vendors	9%	1%	4%	12%	17%	6%	18%
	Lack of technical support from consultants	6%	2%	26%	6%	11%	1%	12%
	Inability to evaluate new products and equipment	14%	13%	29%	11%	17%	7%	22%

Table 10: Obstacles, by Industry (2)

		Roofing	Building Interior	Building Equipment	Electrical	Plumb., Heat. & Air-Condit.	Other
Market							
	High cost of products, systems and equipment	66%	79%	57%	77%	80%	65%
	Lack of interest by clients	…	13%	37%	25%	13%	18%
	Resistance to change by businesses with which your business has joint projects	2%	9%	16%	18%	2%	2%
	Risk of legal liability	…	5%	20%	14%	16%	4%
	Restrictive codes and standards	10%	10%	44%	31%	29%	9%
Human resources							
	Shortage of skilled workers	…	54%	27%	28%	41%	55%
	Lack of in-house expertise	…	51%	23%	21%	22%	18%
	Inability to train workers within the required time	20%	13%	23%	21%	13%	18%
	Worker resistance to change	44%	14%	18%	20%	18%	9%
External support services							
	Lack of technical support from vendors	5%	2%	20%	15%	24%	6%
	Lack of technical support from consultants	1%	2%	8%	5%	9%	6%
	Inability to evaluate new products and equipment	4%	18%	10%	12%	14%	11%

Annex 3: Questionnaire

Science and Technology Redesign Project

Innovation, Advanced Technologies and Practices in the Construction and Related Industries

Confidential when completed

Si vous préférez ce questionnaire en français, veuillez cocher ☐

Please correct name and address if necessary

Information for Respondents

Survey Purpose

The objective of this survey is to provide information on innovation, advanced technology and advanced practices being used in the construction and related industries. The information in the survey can be used by businesses for market analysis, by trade associations to study performance and other characteristics of their industries, and by government to develop national and regional economic policies.

Authority

This survey is conducted under the authority of the Statistics Act, Revised Statutes of Canada, Chapter S19. Completion of this questionnaire is a legal requirement under the Statistics Act.

Confidentiality

Statistics Canada is prohibited by law from publishing any statistics which would divulge information obtained from this survey that relates to any identifiable business without the previous consent of that business. The data reported in this questionnaire will be treated in strict confidence, used for statistical purposes and published in aggregate form only. Statistics Canada will create a data base combining individual survey responses with existing Statistics Canada data records. The confidentiality provisions of the Statistics Act are not affected by either the Access to Information Act or any other legislation.

Assistance

If you require assistance in the completion of this form or have any questions regarding this survey, please contact:

Heather Prieur
Phone: (613) 951-7683
Fax: (613) 951-9920
E-Mail: prieur@statcan.ca

Certification

Please indicate the name of the person completing this form so we know who to contact should we have questions about this report.

Name *(please print)*	Official position:	
Internet address:	Telephone No. ( )	Fax No. ( )

5-4900-486.1: 1999-02-23 STC/SAT-465-75152

Business Environment and Success Factors

1. For <u>your business</u>, please indicate how strongly you agree or disagree with the following statements.

Please indicate your opinion by using the following scale where 1 is strongly disagree and 5 is strongly agree.

	Strongly Disagree		Neutral		Strongly Agree
	1	**2**	**3**	**4**	**5**
My clients' needs are easy to predict	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯
My clients can easily find a substitute for my services	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯
My competitors' actions are easy to predict	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯
My business can easily substitute among suppliers	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯
The arrival of new competitors is a constant threat	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯
Materials and supplies quickly become obsolete	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯
Technologies in the office are changing rapidly	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯
Technologies on the construction/building site are changing rapidly	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯

2. Please rate the importance of each of the following factors for the success of <u>your business</u>.

Please indicate your opinion by using the following scale where 1 is low importance and 5 is high importance. Indicate 0 if not relevant to your business.

	Importance					
	Low				High	Not Relevant
	1	2	3	4	5	0
Strategy within <u>your business</u>						
Developing unique expertise or a unique market	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
Delivering products or services which reduce the client's operating costs	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
Seeking business outside of your present geographical region of activity	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
Increasing your market share	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
Building and enhancing relationships with existing clients	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
Attracting new clients	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
Providing a broader range of services to your clients	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
Ensuring employees are aware of business issues	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
Human Resources within <u>your business</u>						
Encouraging and rewarding your employees to seek out technological improvements	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
Encouraging and rewarding your employees to seek out organizational improvements	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
Providing or supporting training programs for employees	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
Hiring new graduates from colleges and universities	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
Hiring experienced employees	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
Participating in apprenticeship programs	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
Using teams which bring together people with different skills	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
Technology within <u>your business</u>						
Introducing new user-friendly technologies	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
Investing in research and development	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
Protecting intellectual property (patents, trademarks, copyrights, etc.)	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
Enhancing your technical capabilities	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
Participating in the development of industry standards and practices	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯

List of Definitions

Advanced Technologies

Communications

E-mail: Refers to electronic mail.

Digital photography for progress reporting: The use of digital photography to record progress on a work-site so it can be transmitted by electronic means.

Office-to-site video links or video conferencing: The use of video cameras to communicate between the site and other locations. Can be used to solve problems on the site without bringing people to the site.

Company computer network: LAN (local area network) for communications within a building or WAN (wide area network) for communications within a business extending beyond a single building or site.

On-site plant and equipment

Laser-guided equipment: Equipment which incorporates a laser. An example is a bulldozer or a grader with on-board computerized grade information and a laser sensor which assists the operator in excavating/grading to a precise level.

Automated systems and/or programmable machines: Automated systems and programmable machines incorporate computer technologies to carry out specific tasks. Examples include bar code readers and automated welding machines.

GPS (Global Positioning Systems): Surveying equipment that determines the exact position with the aid of satellites. Other applications include the use of GPS to determine the location of delivery trucks or other vehicles.

Materials and systems

High performance concrete: Concrete that has been modified to achieve superior performance in terms of strength or other desired characteristics.

Composite materials (e.g. fiber reinforced plastics) : A synthetic material reinforced with other materials to achieve superior performance characteristics.

Recycled plastics components: Products that incorporate plastics that have already been used and are used to make another product.

Systems

Remote sensing and monitoring systems (e.g. "smart" detection systems): Systems incorporating sensors for monitoring.

Bio-remediation clean-up: Bio-remediation involves the use of microorganisms to clean up contaminated soil.

Preassembled air, water, power distribution systems (e.g. "drop-in" systems): Systems that are produced off-site and transported to the construction site where they are easily installed.

"Clean room" technology: Technology that assures that rooms are super-clean (hospital operating rooms, computer chip fabrication, etc.). Clean rooms require special sub-systems and special materials.

Deconstruction and reuse systems: Taking a building or structure apart in such a manner that materials used can be reused and recycled.

Design

Computer Aided Design (CAD): Use of computer-based software to carry out design. CAD allows engineers, architects, or designers to produce complete designs on the computer screen and to visualize the implications of design changes on other aspects of the design.

Modeling or simulating technologies: Used to provide a computer-based visualization of the performance of a computer aided design. Modeling involves the approximation, representation or idealization of selected aspects of the structure, behavior, operation and characteristics of a real-world process, concept or system. Simulation is a model that behaves or operates like a given system when provided with a set of controlled input.

Electronic exchange of CAD files: Refers to the transfer of computer aided design files. If the exchange is outside of a company, then conversion or translation of the software files may be required because of incompatible software.

Advanced Technologies

3. Please check which of the following advanced technologies <u>your business</u> either:

- **currently uses**
- **plans to use within two years; or**
- **has no plans to use within two years or is not applicable to your business**

	Currently uses	Plans to use within 2 years	No plans/Not applicable
Communications			
E-mail			
Digital photography for progress reporting			
Office-to-site video links or video conferencing			
Company computer networks (LAN or WAN)			
On-site plant and equipment			
Laser-guided equipment			
Automated systems and programmable machines			
GPS (Global Positioning System)			
Materials			
High performance concrete			
Composite materials (e.g. fiber reinforced plastics)			
Recycled plastic components			
Systems			
Remote sensing and monitoring systems (e.g. "smart" detection systems)			
Bio-remediation clean-up			
Preassembled air, water, power distribution systems (e.g. "drop-in" systems)			
"Clean room" technology			
Deconstruction and reuse systems			
Design			
Computer aided design			
Modeling or simulation technologies			
Electronic exchange of CAD files			
Other advanced technologies (*please specify*)			
_____			
_____			

List of Definitions

Business Practices

Computerization

Computerized inventory control: Use of computers to manage a company's inventory.

Computerized estimating software: The use of computer software programs to estimate costs.

Computerized project management and/or scheduling software: The use of computer software to manage and/or schedule projects.

Quality

Quality certification (e.g. ISO 9000, R2000, etc.) : Quality systems that are introduced by a firm and which receive third-party validation. ISO 9000 for example is an internationally recognized series of quality system standards and guidelines used to certify the consistency of the way a business produces and delivers its products and services.

Organization

Written market analysis report to evaluate needs and opportunities of your business: A formal and structured analysis of the market carried out by the business or by a consultant hired by the business. A market analysis would lead to a market plan for the business.

Written documentation of technological improvements developed by your business: A formal and structured process to record and document all technological improvements that are developed by the business.

Written evaluation of new ideas in order to develop options for your business: Formal studies and reports prepared by the business or by consultants hired by a business to assess new ideas that are of interest to the business.

Written strategic plan: A formal and structured process carried out by the business or by a consultant hired by the business which leads to a strategic plan.

Business

Design-build contracts: With design-build contracts, owners specify the time lines and performance criteria sought for a project. In response, design-build teams comprising architects, engineers, contractors and in many cases building materials suppliers submit project proposals that indicate the project's design, cost and completion date. The owner then evaluates the submissions and selects the winning proposals. Significant savings often result from this approach.

Build-operate-transfer (BOT) contracts: An arrangement where the builders of a structure or building operate it for a specified length of time and at the end of the time transfer the building to the original financers.

Post-commissioning inspection and maintenance contracts: Builders obtain an on-going contract to inspect and maintain the structure or building they built.

Long-term working arrangements with other businesses to work together on joint projects : Agreements between different businesses to work together jointly on projects. These working arrangements can be based on a formal contract or on an informal agreement.

Advanced Practices

4. Please check which of the following business practices your business either:

- **currently uses**
- **plans to use within two years; or**
- **has no plans to use within two years or is not applicable to your business**

	Currently uses	Plans to use within 2 years	No plans/Not applicable
Computerization			
Computerized inventory control			
Computerized estimating software			
Computerized project management and/or scheduling systems			
Quality			
Quality certification (e.g. ISO 9000, R2000, etc.)			
Organization			
Written market analysis report to evaluate needs and opportunities of your business			
Written documentation of technological improvements developed by your business			
Written evaluation of new ideas in order to develop options for your business			
Written strategic plan			
Business			
Design-build contracts			
Build-operate-transfer (BOT) contracts			
Post-commissioning inspection or maintenance contracts			
Long-term working arrangements with other businesses to work together on joint projects			
Other advanced practices (*please specify*)			
_____			
_____			
_____			

5. In the past three years has your business:

Please check all that apply.

- Been involved in a merger ☐
- Acquired another business ☐
- Set up a new line of business or a new division ☐

Sources of information

6. Please indicate your sources of information on advanced technologies and advanced practices, such as those listed in Questions 3 and 4.

Please check all that apply.

- Trade shows and conferences ☐
- Trade journals and newsletters ☐
- Trade associations ☐
- Computer based information networks (including internet) ☐
- Suppliers of materials, supplies, machinery and equipment ☐
- Clients ☐
- General contractors ☐
- Specialty trades ☐
- Consulting engineers ☐
- Architects ☐
- Government facility owners or managers ☐
- Non-government facility owners or managers ☐
- Federal information programs ☐
- Federal research organizations ☐
- Provincial research organizations ☐
- Universities and colleges ☐
- Regulatory and standards organizations ☐
- Testing and evaluation service firms ☐
- Business consultants ☐

Other sources of information *(please specify)*

_____

_____

Please list the most important source of information on advanced technologies and advanced practices for your business:

_____

_____

_____

_____

Obstacles

7. Please check the major obstacles for <u>your business</u> to using new and improved building products, building systems and construction equipment.

Please check all that apply

Market:

- ☐ High cost of products, systems and equipment
- ☐ Lack of interest by clients
- ☐ Resistance to change by businesses with which your business has joint projects
- ☐ Risk of legal liability
- ☐ Restrictive codes and standards

Human resources:

- ☐ Shortage of skilled workers
- ☐ Lack of in-house expertise
- ☐ Inability to train workers within the required time
- ☐ Worker resistance to change

External support services:

- ☐ Lack of technical support from vendors
- ☐ Lack of technical support from consultants
- ☐ Inability to evaluate new products and equipment

Other obstacles (*please specify*)

_____

_____

_____

Please list the <u>most important obstacle</u> to using new and improved building products, building systems and construction equipment <u>for your business</u>:

_____

_____

_____

Impact

8. Please provide a brief description of the technological or business practice change or improvement which had the biggest impact on your business during the last three years.

Did this technological or business practice change or improvement provide your business with a significant advantage over your competitors?

Yes ☐ **No** ☐

Comments

Thank you for your co-operation