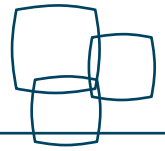


STATE *of* DESIGN



The Canadian Report 2010



***STATE of DESIGN:
The Canadian Report 2010***

This publication is also available electronically on the World Wide Web in html format at the following address: www.ic.gc.ca/pdd

Permission to Reproduce

Except as otherwise specifically noted, the information in this publication may be reproduced, in part or in whole and by any means, without charge or further permission from Industry Canada, provided that due diligence is exercised in ensuring the accuracy of the information reproduced; that Industry Canada is identified as the source institution; and that the reproduction is not represented as an official version of the information reproduced, nor as having been made in affiliation with, or with the endorsement of, Industry Canada.

For permission to reproduce the information in this publication for commercial redistribution, please email: copyright.droitdauteur@pwgsc.gc.ca

ISBN: Iu44-79/2010
978-1-100-51148-1
60712

Aussi offert en français sous le titre
L'ÉTAT de la CONCEPTION de PRODUITS :
Le rapport canadien 2010



Highlights

In today's complex business environment, the extent to which firms invest in product design and development (PD&D) is a key determinant of their competitiveness. In general, Canadian firms that invest more in PD&D generate additional business benefits from new or significantly improved products, including increased revenue and improved access to new export markets.¹

Investment in PD&D by firms can be done either in-house or through outsourcing to PD&D service providers. The PD&D service industry is a technologically vibrant part of the Canadian service economy that supplies critical innovation services to other sectors, notably manufacturers, distributors, and retailers. PD&D serves as a link between creativity, innovation, and commercialization; a clear understanding of the trends and importance of PD&D as a value-added service activity is essential.

Industry Canada has partnered with the Design Exchange (DX) and the Canadian Manufacturers and Exporters (CME) to review the valuable service business function of PD&D. By collecting insights from the industry and international research organizations, and using economic modelling conducted by Industry Canada, this industry-government collaboration has produced a complete user/service provider profile of PD&D in Canada, summarized here in this report. This unique analysis is intended to help Canadian PD&D executives as well as decision makers understand current market trends and recognize the advantages of investing in PD&D to improve business competitiveness.

Key Findings:

- Main PD&D drivers include meeting changing customer preferences and shortening time to market windows.
- In the manufacturing and services sectors, PD&D occupations command nearly a 50% wage premium over the economy average.
- PD&D outsourcing to service providers is forecasted to increase by 20% by 2012 to \$10.6 billion.
- The export intensity of Canadian product design service providers is 2.25 times greater than that of the United States.
- The adoption rates of advanced PD&D technologies are similar between small, medium, and large firms. However, fewer small and medium firms adopt PD&D processes compared to large firms.
- Regardless of business size, over 80% of Canadian firms report a significant improvement in the satisfaction of client needs and product quality as a result of adopting advanced PD&D technologies and processes.

Table of Contents

p.1	.....	Background
3	.....	Product Design and Development Drivers
5	.....	Product Design and Development Investment
5	.....	PD&D Investment – Volume
6	.....	PD&D Investment – Intensity
7	.....	PD&D Outsourcing
9	.....	Intellectual Property Rights
10	.....	The Product Design and Development Service Industry
10	.....	Geographic Distribution
12	.....	Performance
13	.....	Employment and Skills
15	.....	Product Design and Development Innovation
16	.....	Advanced PD&D Technology Adoption
17	.....	PD&D Process Adoption
18	.....	Benefits of Advanced PD&D Technology and Process Adoption
19	.....	Size of Firm Analysis
21	.....	Final Remarks
22	.....	Annex I: Tables
24	.....	References

Table of Figures

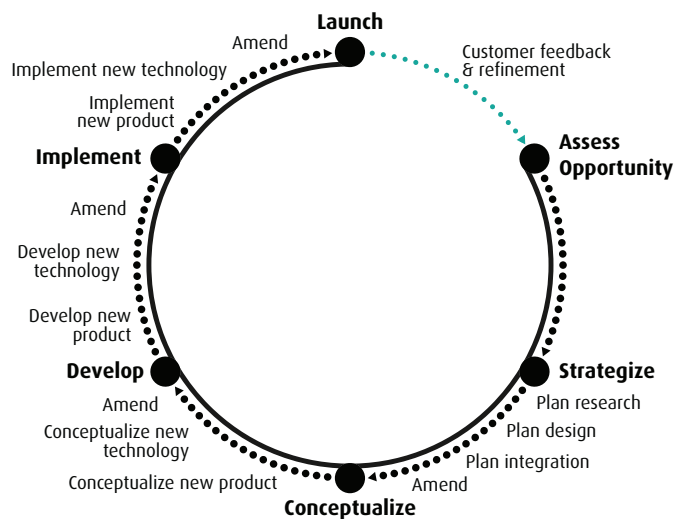
p.1	.....	<i>Figure 1:</i>	Product design and development cycle
3	.....	<i>Figure 2:</i>	Top drivers for PD&D investment
5	.....	<i>Figure 3:</i>	PD&D investment volume – 2008
6	.....	<i>Figure 4:</i>	PD&D investment intensity – 2008
7	.....	<i>Figure 5:</i>	PD&D investment model – 2008
8	.....	<i>Figure 6:</i>	Forecast of PD&D outsourcing – 2005 to 2012
8	.....	<i>Figure 7:</i>	PD&D outsourcing by industry – 2009 to 2012
9	.....	<i>Figure 8:</i>	Use of intellectual property
11	.....	<i>Figure 9:</i>	Geographic distribution of PD&D service providers
11	.....	<i>Figure 10:</i>	Geographic concentration of PD&D service providers
12	.....	<i>Figure 11:</i>	Product design industry revenue growth – 1999 to 2007
12	.....	<i>Figure 12:</i>	Product design industry export intensity – 2007
13	.....	<i>Figure 13:</i>	Product design industry export destinations – 2007
13	.....	<i>Figure 14:</i>	Composition of PD&D occupations – 2008
14	.....	<i>Figure 15:</i>	PD&D employment – 1997 to 2008
14	.....	<i>Figure 16:</i>	PD&D wage premium and earnings growth
16	.....	<i>Figure 17:</i>	Advanced PD&D technology adoption
17	.....	<i>Figure 18:</i>	PD&D process adoption
18	.....	<i>Figure 19:</i>	Benefits of advanced PD&D technology and process adoption
19	.....	<i>Figure 20:</i>	Adoption of advanced PD&D technology and process – business size
20	.....	<i>Figure 21:</i>	Benefits of advanced PD&D technology and process adoption – business size

Background

In a global economy, the extent to which Canadian firms invest in product design and development (PD&D) is a key determinant of their competitiveness, as it allows them to introduce new and innovative products to market. PD&D is a process that links the generation of new ideas and concepts (creativity) to the creation of new products (innovation) and can be done by either manufacturers or service providers. The PD&D process is a cycle of continuous improvement over time with iterative feedback and recurring input from all development team members. The PD&D cycle involves six stages: *assess opportunity*; *strategize*; *conceptualize*; *develop*; *implement*; and *launch* (Figure 1).

Figure 1

Product design and development cycle²



The process begins with an *assessment of opportunity*, such as an unmet consumer need, to determine whether a new product idea is viable for a company. In the *strategize* stage, the development team will assess what resources are required and carry out design research. Following this are the *conceptualize* and *develop* stages where mock-up, product evaluation, modelling, prototyping/testing, and refinement activities are completed. Once a product has been successfully designed it is then integrated into the production process in the *implement* stage, where detailed specification and coordination activities take place. Ultimately, the new product is then promoted and launched in the marketplace. A key component of the PD&D cycle is consumer feedback and refinement following the launch of the product. This process leads to improvements and new opportunities for the next iteration of the cycle.²

Canadian manufacturers and service providers can benefit from quality and timely information on PD&D trends and performance indicators. This strategic information can also be used to identify best practices, develop benchmarks, justify investment and innovation decisions, and help inform policy makers of current and future industry needs.

This report provides insights on:

- Current pressures driving firms to invest in PD&D;
- PD&D investment by industrial sectors in 2008;
- Growth forecast of PD&D outsourcing up to 2012;
- PD&D service industry profile: geographic distribution, revenue and export intensity;
- Skills and employment;
- Adoption of advanced PD&D technologies and processes; and
- Business benefits of adopting advanced PD&D technologies and processes.

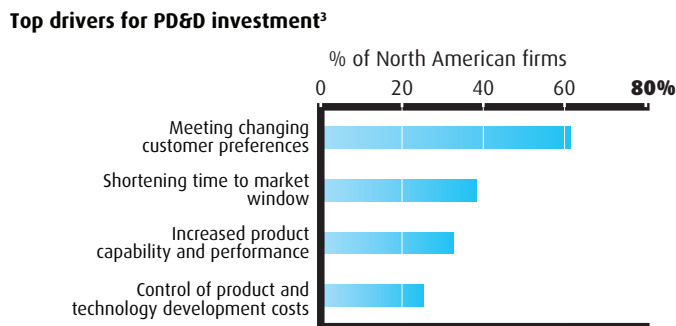
Approach and methodology

This report is based on a collaborative undertaking between the Design Exchange (DX), Canadian Manufacturers and Exporters (CME) research committee, and Industry Canada's Service Industries and Consumer Products Branch. The DX/CME research committee defined industry needs, drivers, and metrics and offered valuable insights from an industry perspective. By using information from industry partners and international research organizations, and by applying unique economic models developed in-house, Industry Canada provided the overall analysis and brought together all the components needed to produce Canada's first *State of Design* report.

Product Design and Development Drivers

Several pressures are driving firms to invest in PD&D to create innovative products. In general, North American firms perceive changing customer preferences and shortening time to market windows as the main drivers to invest in PD&D (Figure 2). Consumer preferences often dictate innovation as firms strive to deliver timely products to satisfy the changing needs of consumers. In addition, time to market windows are becoming tighter as businesses seek to launch products ahead of their competitors to capture increased market share and higher margins. There are also internal pressures prompting firms to invest in PD&D such as the need to control product and technology development costs.³

Figure 2



With numerous pressures driving firms to invest in PD&D, diverse design requirements must be balanced in the *strategize*, *conceptualize*, and *develop* stages of the PD&D process. For this reason, many firms use Design for X (DfX) tools within their PD&D processes. In general, DfX is an approach to PD&D directed at maximizing the product requirements demanded (such as assembly, quality, disassembly, manufacturability, safety, and environmental friendliness) and simultaneously minimizing cost.⁴ As an example, with increased consumer concern for the environment, some Canadian firms are implementing Design for Environment (DfE) practices within their operations to meet changing consumer preferences while increasing access to foreign markets and decreasing costs.*

PD&D is not without challenges. One key difficulty is to minimize the gap between the design and engineering departments. The voice of the customer needs to carry through to the end product, while the product itself must be manufacturable and meet production cost targets. Another substantial challenge lies in making the PD&D process seamless with minimal time and expense spent modifying the design. Iterations are a natural part of the process; however, correcting problems in the early stages is optimal.²

* See Industry Canada's *Design for Environment: Innovating to Compete* for a complete overview of the use of DfE practices and their business benefits for Canadian firms.

The details of a PD&D process are industry- and firm-specific. However, several core approaches to PD&D are central to industrial goods manufacturers and demonstrate the importance of PD&D to the success of a firm. One major approach to PD&D is Design for Manufacturing and Assembly (DFMA), which focuses on making production as easy and economical as possible in the design stage. This can include designing a product to have fewer parts overall and more standardized parts and materials. Other guidelines within the DFMA approach include designing for parts orientation and handling to minimize effort in adjusting and merging parts, and designing for ease of fabrication. A focus on DFMA can significantly improve the manufacturing process by reducing assembly time and costs.⁴

Another approach to PD&D is to take a broader perspective and identify the needs of all stakeholders, including those of the end user, the manufacturer(s), sales, retail, marketing, and regulatory compliance. Common ground and priorities are established and agreed to, and PD&D efforts are then focused on generating solutions that best satisfy the range of requirements.²

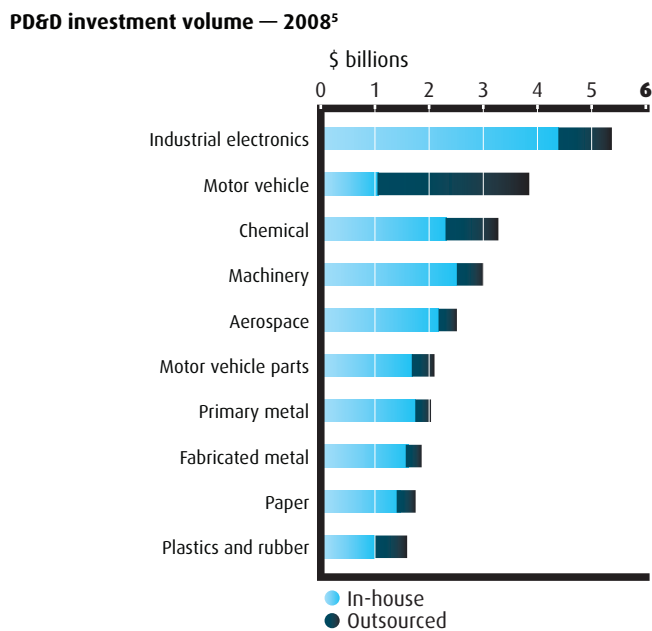
Product Design and Development Investment

Investment in PD&D by firms can either be done in-house or through outsourcing. In-house PD&D is defined as the internal investment that a sector makes in terms of the personnel and capital related to PD&D. Outsourced PD&D is defined as the purchase of PD&D services from service providers in Canada or abroad. Two measures present a comprehensive view of PD&D in Canada: absolute dollars represent the PD&D investment volume, and intensity represents the importance of PD&D to individual industrial sectors.

PD&D Investment – Volume

In 2008, the Canadian manufacturing sector invested \$38.6 billion in PD&D. Of this investment, 26% was outsourced to PD&D service providers.[†] In terms of manufacturing sectors, the industrial electronics industry is the largest PD&D investing sector in Canada with approximately \$5.4 billion in 2008, followed by the motor vehicle, chemical, and machinery industries, with approximately \$3.9, \$3.3 and \$3.1 billion, respectively (Figure 3).

Figure 3



[†] For a detailed breakdown of PD&D investment, see Annex I.

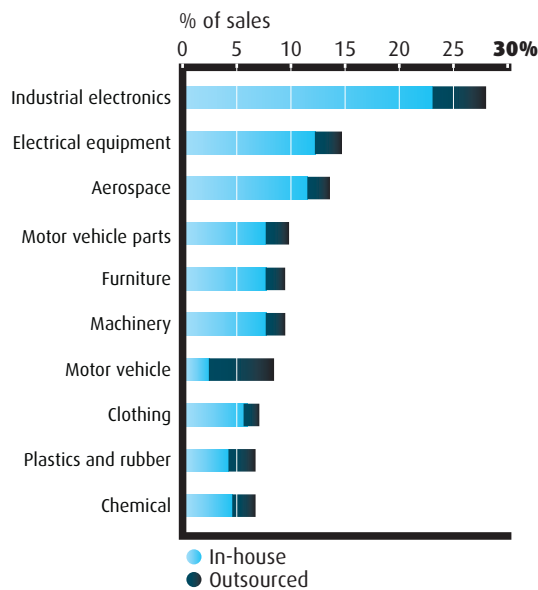
PD&D Investment – Intensity

PD&D investment intensity[†] is a measure of how critical PD&D is to a particular industry.[‡] The variability of PD&D intensity across industries is influenced by different market structures, levels of competition and business models. For example, the industrial electronics industry is characterized by the need for highly specialized skills and substantial costs of investment. Driven by a desire for market control in a competitive market structure, firms within this industry focus PD&D investments on developing breakthrough technological innovations and improved product architecture.²

The shift in industry ranking between PD&D investment intensity and dollars invested is notable. For example, even though the electrical equipment and aerospace industries have relatively low investment volumes in PD&D, the importance of product introduction and improvement is signified by their high investment intensity (Figure 4). In the aerospace industry new products are highly complex and require a long PD&D cycle to develop; as a result, aerospace firms invest continuously in PD&D.

Figure 4

PD&D investment intensity — 2008⁵



[†] PD&D investment intensity is defined as PD&D investment divided by sales.

[‡] For a detailed breakdown of PD&D intensity, see Annex I.

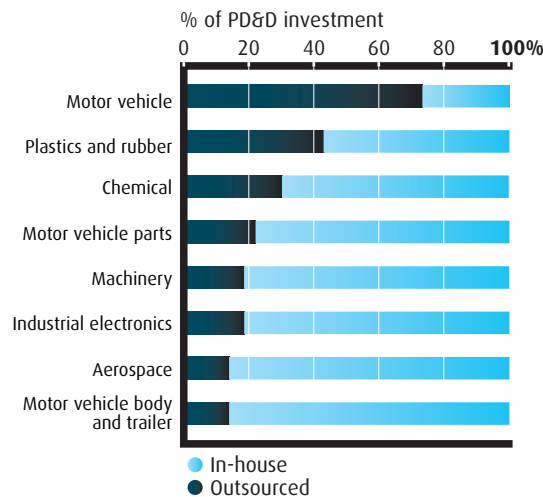
The Canadian furniture industry also has a high PD&D investment intensity even though the industry invests a small amount in absolute terms. Many office furniture manufacturers are investing in PD&D, have a large design-oriented focus, and are developing mass customization/ design solutions for their customers, as a means to differentiate themselves from producers who rely on lower labour costs.²

PD&D Outsourcing

At the macro level, the manufacturing sector in Canada conducts the majority of its PD&D in-house. In contrast, the motor vehicle sector outsourced 76% of its PD&D activities to suppliers and service providers – significantly more than the outsourcing average of 26% (Figure 5). For Canadian automotive manufacturers, 97% of outsourced activity is PD&D engineering services required to integrate new product line requirements from supply chain partners, while the remainder is computer systems and software development.⁵ Conversely, most PD&D performed by motor vehicle parts manufacturers is done in-house once product specifications are delivered by the original equipment manufacturers.²

Figure 5

PD&D investment model – 2008⁵



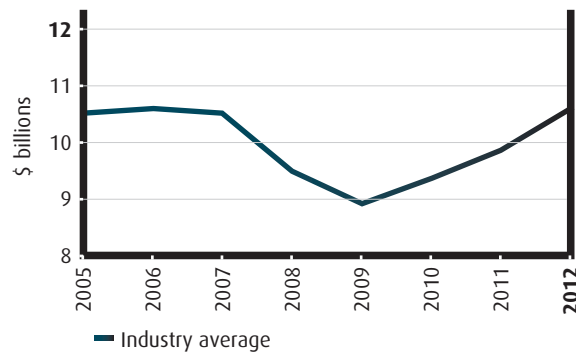
In 2008, as risk spread from the financial to non-financial sectors, firms postponed their intended outsourcing investments to remain solvent. Prior to this decrease, the expansion of the global economy had generated many successful product lines. During the recent economic downturn, the overarching PD&D strategy for many firms has been to reduce costs of existing

products without introducing new discretionary features in response to price-sensitive markets. With this objective, constrained firms naturally reduce their PD&D investment levels.²

As firms begin to rebuild their financial positions and regain confidence in the market, PD&D investment strategies shift to enhanced cost reductions and new product introductions. As early adopters[†] re-enter the market, firms compete again with new features as differentiating factors.² By 2012, PD&D outsourcing by Canadian firms to service providers is expected to rebound strongly and increase by 20% to \$10.6 billion (Figure 6).

Figure 6

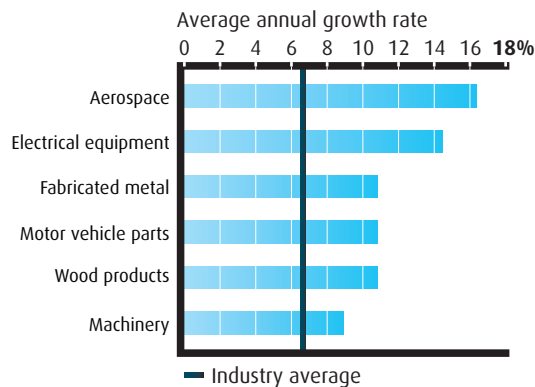
Forecast of PD&D outsourcing — 2005 to 2012⁶



This forecasted growth in PD&D outsourcing is expected to be driven mainly by industrial goods sectors. The aerospace, electrical equipment, fabricated metal, motor vehicle part, and wood product industries are expected to increase their PD&D outsourcing activities by over 10% per year (Figure 7).

Figure 7

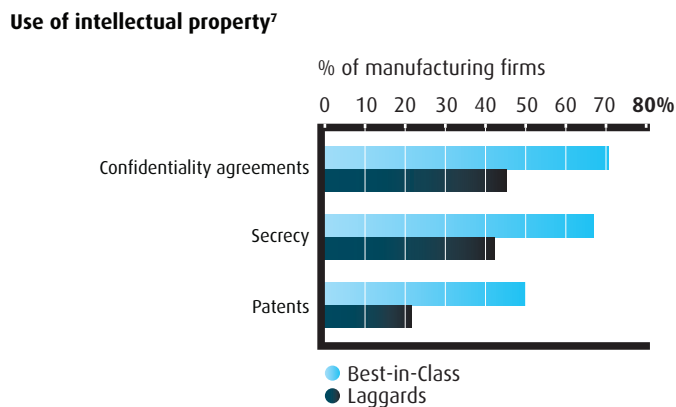
PD&D outsourcing by industry — 2009 to 2012⁶



Intellectual Property Rights

A greater proportion of Best-in-Class firms[‡] adopt measures to ensure the legal protection of intellectual property (IP). Different methods exist to prevent imitation and protect ideas; examples include, but are not limited to, confidentiality agreements, secrecy, and patents. As a result of securing IP protection, firms have greater ability to protect their competitive advantage of being first to market.

Figure 8



In addition, securing intellectual property rights (IPRs) has become an important aspect of outsourcing between manufacturers and PD&D service providers, as 68% of North American firms perceive an increased risk to their product IP protection due to the globalization of markets.⁸

Service providers can assist businesses in protecting IP by specifying ownership of the IPR at the onset of a project. For example, service providers can agree to assign IPRs after the contract's completion; this means that the IPR is assigned to the service provider for the duration of the outsourcing contract and will transfer back to the customer upon completion of the project. Under this arrangement, the service provider may cooperate in preparing patent applications or can maintain the PD&D process as a trade secret.⁸

[‡] Best-in-Class firms are defined as those that generate more than 35% of their revenue from new or significantly improved products.

The Product Design and Development Service Industry

The PD&D service industry is an important part of the Canadian service economy that supplies critical innovation services to many other industries such as manufacturing, distribution, and retail. The PD&D industry is primarily engaged in developing professional designs and specifications through a pragmatic development approach that optimizes the function, value, usability and appearance of products. These services can include material selection, construction, mechanisms, shape, and surface finishes of the product, taking into account a host of considerations such as human needs, safety, the environment, development timeline, production cost, maintenance, and distribution.⁹

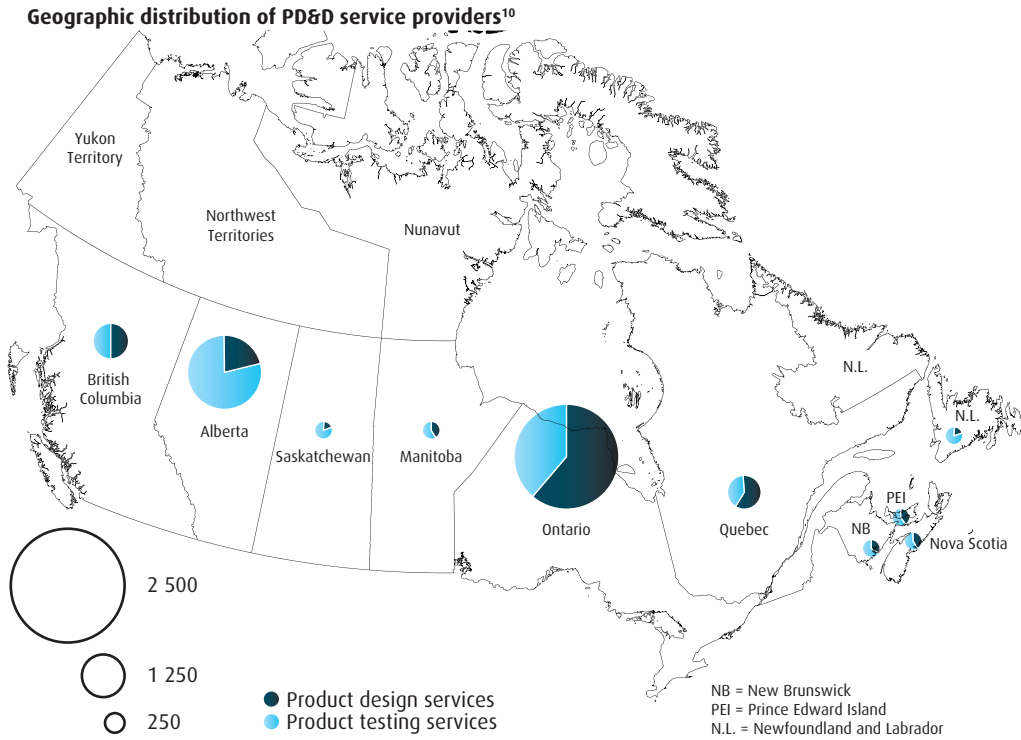
For the purpose of this report, the PD&D industry is categorized into two broad sub-sectors: product design services and product testing services.

- The product design category includes two industries – industrial design and consumer fashion design services:
 - The industrial design industry is engaged in creating and developing designs and specifications that optimize the function, value and appearance of products.
 - The consumer fashion design industry is engaged in clothing, jewellery, shoe, textile, and general fashion design services.
 - Product testing service firms are engaged in providing physical, chemical and other product-related testing services.
-

Geographic Distribution

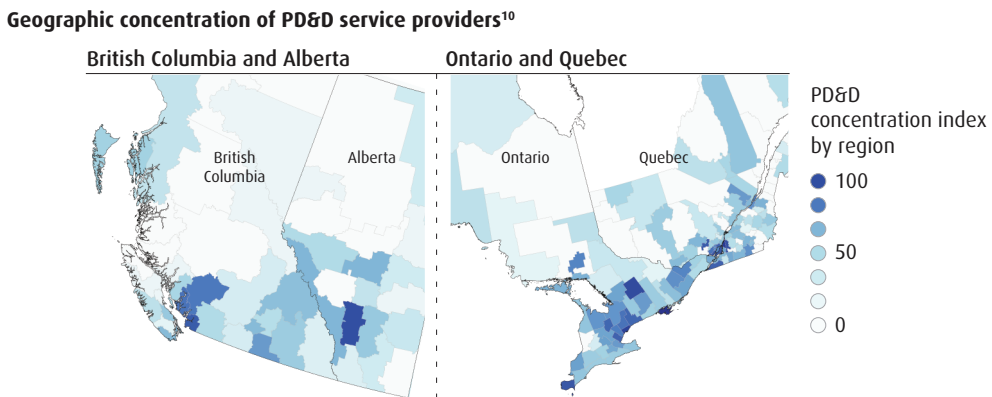
In 2008, the majority of PD&D service providers were located in central and western Canada with approximately 2 400 establishments in Ontario, 1 000 in Quebec, 1 900 in Alberta, and 980 in British Columbia (Figure 9). Most PD&D service firms are small in size – between 1 and 19 employees – with a number of them focusing on only providing upfront strategic PD&D planning and assessment services; a high value-added activity for their customers' business strategy.²

Figure 9



The highest concentrations[†] of PD&D service providers are found near large metropolitan areas. The most geographically concentrated regions are located around Montréal, Toronto, Calgary, and Vancouver – all of which have strong design communities (Figure 10).

Figure 10



[†] Concentration is defined as the number of PD&D service providers divided by the total number of all business establishments in a geographical location.

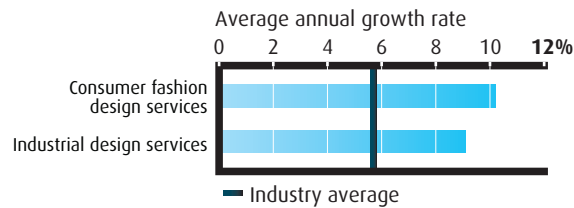
Between 2000 and 2008, some product design firms have consolidated, boosting the number of medium and large firms in Canada. This is partly due to the fact that some Canadian service providers are seeking to be total package providers and offer a full spectrum of design services – not uncommon considering the most commercially successful design service providers in the United States, United Kingdom, Italy, and France operate as total package providers.² Firms are increasingly seeking complete design service solutions to avoid scattering their outsourcing contracts across too many channels and to minimize transaction costs.¹¹

Performance[‡]

The Canadian product design service industry has outperformed the Canadian economy by 60% in terms of revenue growth over the 1999 to 2007 period. Revenue for the Canadian consumer fashion design sector has increased by 10% a year over the same period, and revenue growth for industrial design services has also been strong with average annual growth of 9% (Figure 11). Also in 2007, the industrial design and consumer fashion design industries had profit margins of approximately 12% and 11%, respectively.¹²

Figure 11

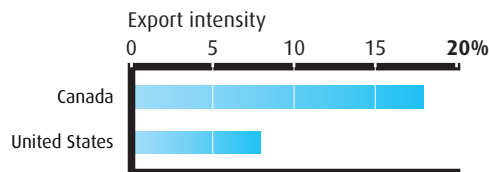
Product design industry revenue growth — 1999 to 2007¹²



With a relatively small domestic market, Canadian design firms focus more on exporting their services compared to U.S. design service providers. In fact, the export intensity* of Canadian product design industry is 2.25 times greater than U.S. firms, with exports totalling \$83 million in 2007 (Figure 12).

Figure 12

Product design industry export intensity — 2007¹³



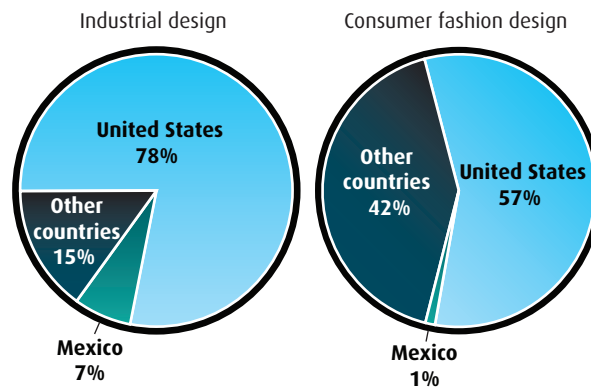
[‡] Due to data availability, this section does not cover product testing laboratories.

* Export intensity is defined as export revenue divided by total revenue.

The majority of Canadian product design services exports are to the United States, with a large proportion being industrial design, product modelling, and prototyping services. A sizable portion of design exports to other markets are clothing, textile, and jewellery design services. The industrial design service industry exports 78% of its services to the United States and an additional 7% to Mexico. The consumer fashion design service industry is focused more on export markets outside of North America (Figure 13).

Figure 13

Product design industry export destinations — 2007¹²

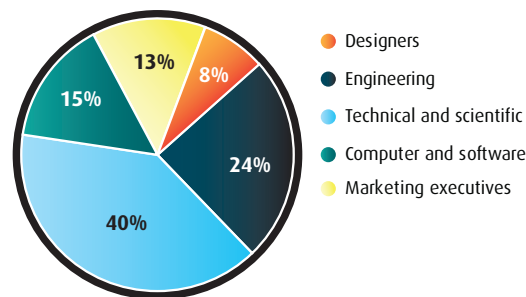


Employment and Skills

The PD&D process requires a wide range of highly advanced skills throughout its six stages. Approximately 225 000 people are employed in PD&D occupations within the manufacturing and PD&D service sectors.¹⁴ The largest share of employment is in technical and scientific occupations. In addition, a large base of product engineers is employed within the process (Figure 14).

Figure 14

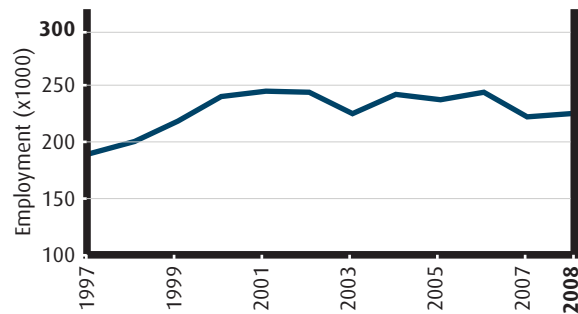
Composition of PD&D occupations — 2008¹⁴



From 1997 to 2001, PD&D employment increased by 25% to 245 000. Over this period, employment within the PD&D service industry – which encompasses 15% of total PD&D employment – grew by 77%, while PD&D employment in the manufacturing sector increased by 20%. Following this period, PD&D employment has remained stable in Canada with slight cyclical changes (Figure 15).

Figure 15

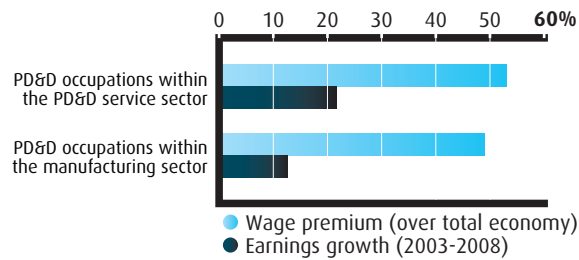
PD&D employment — 1997 to 2008¹⁴



The PD&D process also requires highly educated employees. In fact, 47% require either a university or a college degree, and another 41% of PD&D occupations require at least a university education. As a result, PD&D occupations command close to a 50% wage premium over the economy average, with yearly salaries averaging \$60 700 and \$62 600 within the manufacturing and the PD&D service sector, respectively (Figure 16).

Figure 16

PD&D wage premium and earnings growth¹⁴



Product Design and Development Innovation

Canadian firms are changing the way they conduct PD&D to better respond to the challenges of product innovation; as a result, firms are improving their business performance. Innovation in the PD&D process is captured in two ways: the adoption of advanced PD&D technologies, and the use of new PD&D processes. For the purpose of this report, advanced PD&D technologies include virtual product development and rapid prototyping, and PD&D processes include concurrent design/engineering, cross-functional design teams, and e-based design/engineering processes.

Virtual product development (VPD) refers to the use of simulation software or services throughout the PD&D process.

Rapid prototyping refers to the use of additive fabrication technologies that facilitate the construction of a 3D model of a physical object directly from a computer-aided design (CAD) file in a relatively short amount of time compared to traditional prototyping methods.

Concurrent design/engineering refers to design and engineering activities conducted simultaneously – rather than sequentially – with design work and other developmental processes.

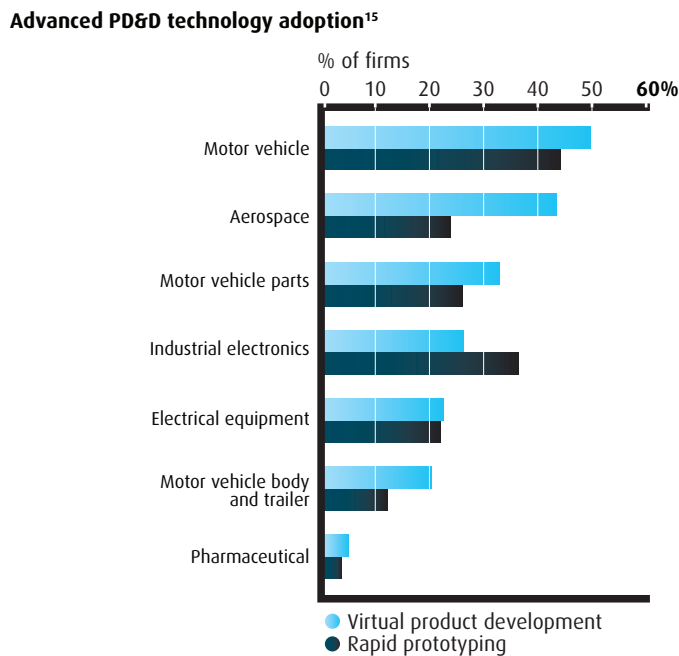
Cross-functional design teams are defined as groups that include people from all relevant functional areas responsible for PD&D, with customized teams often assembled on a per-project basis.

E-based (online) design/engineering consists primarily of a service derived from an e-sourcing-based solution. Items can include electronic forms and custom programs. This involves the use of electronic techniques to carry out business transactions, including electronic mail or messaging, internet technology, electronic bulletin boards, purchase cards, electronic funds transfers and electronic data interchange.

Advanced PD&D Technology Adoption

Virtual product design (VPD) and rapid prototyping enable firms to perform faster product iterations to meet shrinking time to market windows. Notably, the top adopters of advanced PD&D technologies are industrial product sectors, as opposed to consumer products. The adoption of advanced PD&D technologies and the technology mix vary greatly by industry.¹⁵ For example, the use of VPD technologies in the aerospace industry is more common than rapid prototyping. For this industry, VPD includes digital preassembly and 3D build simulation – much more efficient than large-scale physical mock-ups (Figure 17).

Figure 17



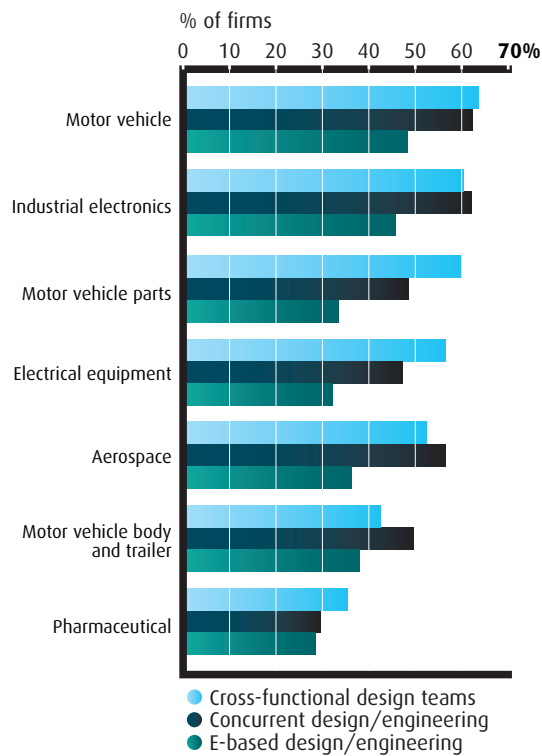
Conversely, the use of rapid prototyping technology is more common in the industrial electronics industry. The ability to conduct rapid prototyping with key partners – including suppliers – is essential for market leadership. Rapid prototyping allows the construction of physical prototypes quickly, depending on part size and complexity, which traditionally can take weeks or months.¹⁶

PD&D Process Adoption

Compared to the adoption of advanced PD&D technologies, the adoption of organizational processes across industries is more consistent. The top three industries with the highest adoption rate of cross-functional design teams are motor vehicle, motor vehicle parts, and industrial electronics (Figure 18).

Figure 18

PD&D process adoption¹⁵



The top three industries with the highest adoption rate of concurrent design/engineering processes are the motor vehicle, industrial electronics, and aerospace sectors. Different decision-makers in the PD&D process – for example, product designers or manufacturers – have their own sets of requirements to fill, while maintaining the overarching objective of maximizing end-user satisfaction. Concurrent design/engineering, as a more cost-effective and efficient design method, essentially facilitates the optimization of different design parameters, such as product performance and product manufacturing cost. E-based design or engineering is an emerging process innovation that helps leverage cross-functional design teams and concurrent design/engineering, interconnecting global supply chain partners. Although the

adoption of e-based design is currently lower than other PD&D processes, it is expected to be more prevalent in the near future.²

Benefits of Advanced PD&D Technology and Process Adoption

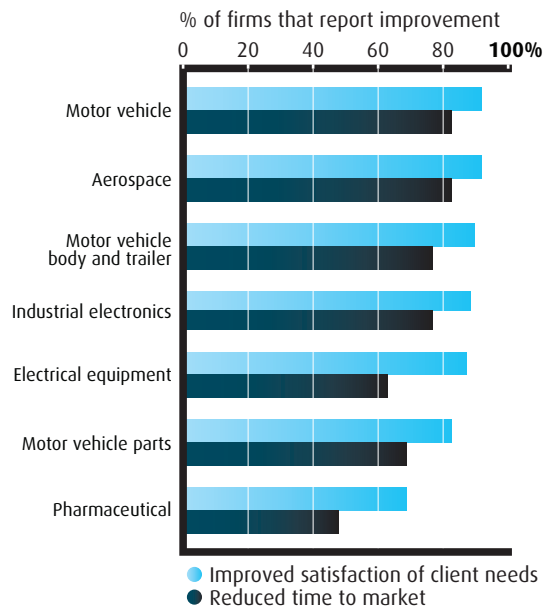
For this report, reduced time to market (defined as the time required from conceptualization of a product idea to readiness for distribution) and improved satisfaction of client needs were chosen as key business benefits resulting from adopting advanced PD&D technologies and processes. These two dimensions quantify the extent to which advanced PD&D technologies and processes enable firms to react to top PD&D drivers: a firm's response to pressure to meet changing customer preferences can lead to improved satisfaction of client needs, while the firm's response to shrinking time to market windows can reduce that firm's own time to market.

As a result of adopting advanced PD&D technologies and processes, 84% of Canadian manufacturers on average are seeing significant improvement in the satisfaction of their client needs and 66% are reducing their time to market.¹⁵

Advanced PD&D technologies can help firms improve the satisfaction of their client needs in two ways. The technologies can be used to validate design in the early stages of the PD&D process to detect errors and flaws, and they can be used to prevent miscommunication of design concepts – especially with increasing product complexity and cost pressures.¹⁷

Figure 19

Benefits of advanced PD&D technology and process adoption¹⁵



Across Canadian manufacturing sectors that adopt advanced PD&D technologies, improved client satisfaction is more commonly achieved as a business benefit than reduced time to market (Figure 19). Advanced PD&D technologies and processes also generate more conventional benefits such as new product features and improved product quality. Of advanced PD&D technology and process adopters, 87% report a significant improvement in product quality and 67% report improvement in new product features.[†]

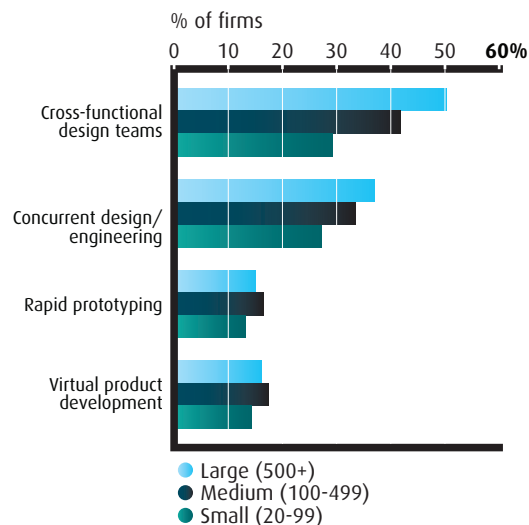
Size of Firm Analysis

Compared to large-scale businesses, fewer small- and medium-sized firms (SMEs) are adopting PD&D processes.[‡] For example, large firms are 28% more likely to utilize concurrent design/engineering techniques compared to small firms and are 41% more likely to use cross-functional design teams (Figure 20). SMEs are less likely to implement concurrent design/engineering since the process is most effective when applied to long and complex PD&D cycles – an attribute more common in large firms. As a corollary, SMEs also adopt cross-functional design teams less as it is often a prerequisite for concurrent design/engineering.

Interestingly, the adoption rates of advanced PD&D technologies are similar between small, medium and large firms (Figure 20). The main reason for this is the recent introduction of more cost-effective solutions accessible to SMEs. Rapid prototyping has become more cost-effective through the introduction of affordable 3D printer technology, which can be one-tenth the cost of more sophisticated rapid prototyping options.² Also, affordable virtual product development technologies are available including cost-effective visualization, simulation, and 3D collaboration tools.²

Figure 20

Adoption of advanced PD&D technology and process — business size¹⁵



[†] See Annex I for a detailed breakdown of PD&D technology/process adoption and benefits.

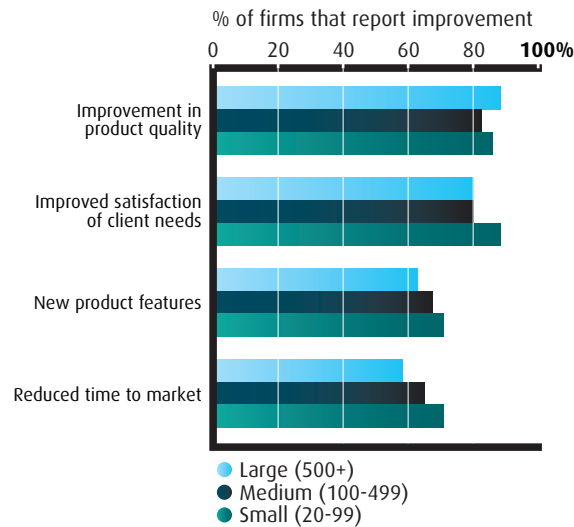
[‡] Small-, medium-, and large-scale businesses are defined as companies with 20 to 99 employees, 100 to 499 employees, and over 500 employees, respectively.

The adoption of advanced PD&D technologies is less prevalent than PD&D processes in general. Since PD&D is done collaboratively with many supply-chain partners, each partner must adopt the same process to coordinate successfully. However, it is not necessary for all the partners to adopt advanced PD&D technologies since a limited number of PD&D project contributors are usually responsible for prototyping and virtual product development.²

Small-, medium-, and large-scale Canadian firms perceive similar business benefits from adopting advanced PD&D technologies and processes. Regardless of business size, over 80% of Canadian firms report a significant improvement in the satisfaction of client needs and product quality (Figure 21).

Figure 21

Benefits of advanced PD&D technology and process adoption — business size¹⁵



However, a greater proportion of SMEs report a reduction in time to market (Figure 21). Reducing their time to market helps SMEs further enhance their lead-time advantage on which they rely more to protect their IP compared to patents, confidentiality agreements, or secrecy.²

Final Remarks

PD&D is an essential discipline that helps firms create, innovate, and commercialize. The process involves interplay between design, engineering, scientific research, and business strategy forming a systematic approach integrating holistic-thinking, research methods, and strategic planning. It is an integral part of manufacturers' operations, with Canadian manufacturers investing \$38 billion in 2008. Canada's vibrant PD&D service sector provides business services to Canadian manufacturers and clients abroad. The performance of the product design industry has been very strong, with above-average revenue and wage growth.

In both the manufacturing and services sectors, the process of PD&D employs 225 000 highly skilled workers who earn nearly a 50% wage premium for providing value-added business services that can improve a firm's competitiveness and its ability to adapt to changing market conditions.

For policy makers, the findings presented in this report draw important linkages between the drivers for investing in PD&D, innovation, firm activities, and resulting business benefits. These connections can help inform a continued dialogue across government and with stakeholders. This report also sets the stage for those interested in PD&D trends to pursue new research opportunities and projects.

*Annex I: Tables**

2008 PD&D Investment

	(\$ billions)			(% of sales)		
	In-house	Outsourced	Total	In-house	Outsourced	Total
Total manufacturing	28.29	10.38	38.67	4.7%	1.7%	6.4%
Industrial electronics	4.43	0.93	5.36	23.1%	4.8%	27.9%
Motor vehicle	1.02	2.85	3.87	2.2%	6.0%	8.2%
Chemical	2.33	1.03	3.35	4.5%	2.0%	6.6%
Machinery	2.52	0.55	3.07	7.5%	1.6%	9.2%
Aerospace	2.14	0.37	2.51	11.6%	2.0%	13.6%
Motor vehicle parts	1.64	0.44	2.08	7.5%	2.0%	9.5%
Primary metal	1.73	0.32	2.05	3.1%	0.6%	3.7%
Fabricated metal	1.51	0.36	1.87	4.1%	1.0%	5.1%
Paper	1.39	0.35	1.74	4.8%	1.2%	5.9%
Plastics and rubber	0.91	0.65	1.56	3.9%	2.8%	6.6%
Electrical equipment	1.26	0.25	1.51	12.1%	2.4%	14.5%
Petroleum and coal	1.02	0.36	1.38	1.3%	0.4%	1.7%
Food	0.65	0.62	1.27	0.8%	0.8%	1.6%
Furniture	1.01	0.21	1.23	7.7%	1.6%	9.3%
Printing and related support activities	0.66	0.19	0.85	6.3%	1.8%	8.0%
Wood	0.56	0.22	0.78	2.6%	1.0%	3.6%
Beverage and tobacco	0.44	0.22	0.66	4.1%	2.1%	6.2%
Non-metallic mineral	0.21	0.14	0.35	1.5%	1.0%	2.4%
Clothing	0.18	0.05	0.23	5.5%	1.4%	6.9%
Motor vehicle body and trailer	0.16	0.03	0.18	4.2%	0.7%	4.9%

* Industry Canada. Economic modelling based on data from Statistics Canada (Census, LFS and Input-Output tables), 2009.

Annex I: Tables[‡]

Advanced PD&D Technology Adoption (% of firms)

	Computer- aided design (CAD)	Electronic exchange and management of CAD files	Rapid prototyping	Virtual product development
Total manufacturing	51%	44%	14%	15%
Motor vehicle	100%	82%	44%	49%
Aerospace	85%	89%	24%	43%
Motor vehicle parts	77%	73%	26%	33%
Industrial electronics	76%	65%	36%	26%
Electrical equipment	72%	58%	22%	22%
Motor vehicle body and trailer	68%	52%	12%	20%
Pharmaceutical	29%	27%	3%	4%

PD&D Process Adoption (% of firms)

	Concurrent design/ engineering	Cross-functional design teams	E-based (online) design or engineering
Total manufacturing	36%	50%	11%
Motor vehicle	62%	64%	48%
Industrial electronics	62%	60%	45%
Aerospace	57%	52%	36%
Motor vehicle body and trailer	49%	42%	37%
Motor vehicle parts	48%	60%	33%
Electrical equipment	47%	56%	32%
Pharmaceutical	29%	35%	28%

Benefits of Advanced PD&D Technology and Process Adoption

(% of firms that report improvement)

	New product features	Improvement in product quality	Reduced time to market	Improved satisfaction of client needs
Total manufacturing	69%	86%	67%	85%
Motor vehicle	100%	95%	82%	91%
Industrial electronics	81%	91%	76%	88%
Electrical equipment	74%	79%	61%	86%
Aerospace	72%	85%	82%	90%
Motor vehicle parts	72%	89%	67%	82%
Motor vehicle body and trailer	66%	87%	76%	89%
Pharmaceutical	43%	89%	46%	67%

‡ Statistics Canada. Customized tabulation from the *Survey of Advanced Technology*, 2007.

References

1. Industry Canada. *Product Design and Development: A Canadian Manufacturing Perspective*, 2008.
2. Design Exchange and Canadian Manufacturers and Exporters research committee, 2009.
3. Aberdeen Group. *The Innovator's Toolbox*, 2009.
4. Huang, G.Q., *Design for X: concurrent engineering imperatives*, 1996.
5. Industry Canada. Economic modelling based on data from Statistics Canada (Census, LFS and Input-output tables), 2009.
6. Informetrica. Input-output forecasts, 2009.
7. Statistics Canada. Customized tabulation from the *Survey of Innovation*, 2005.
8. Aberdeen Group. *Design Anywhere*, 2009.
9. Statistics Canada. North American Industrial Classification System, 2009.
10. Statistics Canada. *Business Patterns Survey*, 2008.
11. Macpherson, A., & Vanchan, V. *The Recent Growth Performance of US Firms in the Industrial Design Sector: An Exploratory Study*, Industry and Innovation, 2008.
12. Statistics Canada. Customized tabulation from the *Survey of Service Industries: Specialized Design Services*, 2008.
13. United States Census Bureau & Statistics Canada. *Service Annual Survey* and customized tabulation from the *Survey of Service Industries*, 2007.
14. Statistics Canada. Customized tabulation from the *Labour Force Survey*, 2008.
15. Statistics Canada. Customized tabulation from the *Survey of Advanced Technology*, 2007.
16. McGrath, M. E., *Setting the PACE in Product Development*, 1996.
17. Grimm, T. *User's guide to rapid prototyping*, 2004.