Technological Transformations and the Automotive Services Industry

Meeting the Skills Challenges for Automotive Service Technicians in Québec

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The research activities of the Interuniversity Research Centre on Globalization and Work (CRIMT) focus on the theoretical and practical challenges of institutional and organizational renewal in the areas of work and employment in the global era. Its *Institutional Experimentation for Better Work Partnership Project* – funded by the Social Sciences and Humanities Research Council of Canada and the Canada Foundation for Innovation – brings together CRIMT (funded by the Fonds de recherche du Québec – Société et culture) and an international network of leading partner centres (20) and coresearchers (180). This vast multi-year project seeks to build knowledge on and understanding of how to make work better. The focus is on actors from the world of work who – in a context of great uncertainty – engage in forms of social experimentation and on why these sometimes lead to better or worse work.

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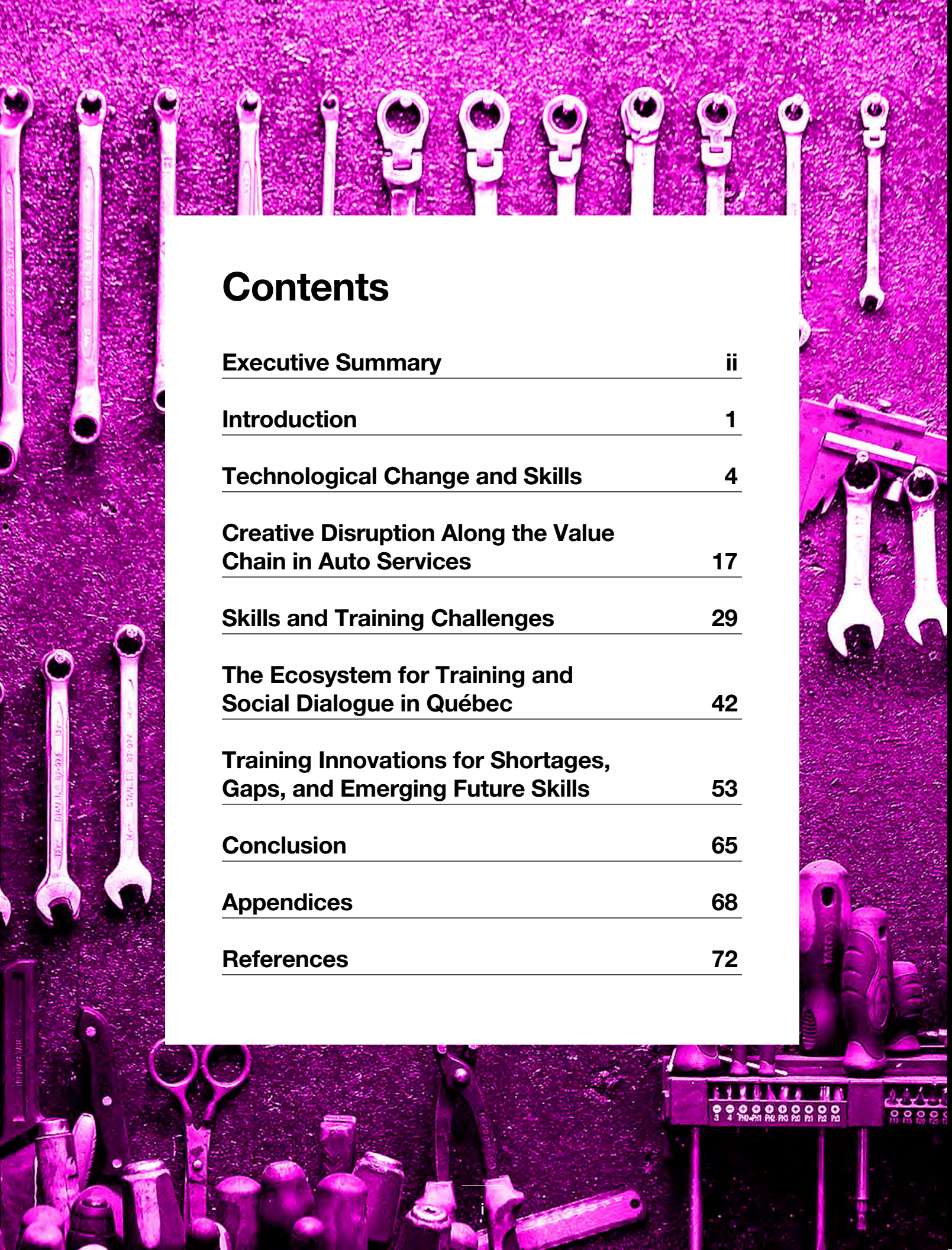

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Executive Summary

This report examines the challenges facing the automotive services industry in Québec as it transitions from selling and servicing traditional combustion-engine vehicles to new generations of motor vehicles. These new models are computerized and connected through sophisticated on-board diagnostic (OBD) systems, integrate advanced driver-assistance systems (ADAS), and are often propelled by hybrid and electric motors.

This technological shift has disrupted traditional business models in a complex multi-tiered industry that ranges from manufacturing, sales, and services to parts distribution, repairs, and recycling. Its impacts have multiple implications for future skills requirements and the provision of skills training. The skills challenges involved in transitioning a workforce from traditional sales and servicing to a much more innovation- and technology-focused industry provide the main focus of this report.

The automotive services industry provides a good illustration of how technological change is impacting a fairly traditional industry, in which the skill base is not necessarily where it needs to be, and the basic and lifelong training systems are showing several gaps. This study examines auto services in Québec, with a focus on the automotive service technicians (primarily mechanics) who ensure the maintenance and repair of motor vehicles in dealerships, as well as aftermarket services for those vehicles.

The report examines how diverse actors in the Québec auto services industry—including large-scale manufacturers, small and medium-sized enterprises (SMEs), their value chains, trade unions, labour–management joint committees, training bodies, and government agencies—are developing practices to fulfill the need for new skills and address issues related to jobs and work. Our study shows that the strategies used to respond to skills shortages, gaps, and future skills challenges are an apt reflection of the complex architecture of the sector. The study also shows how various stakeholders can be brought into the implementation of policy and practice for skill development and innovations in the training ecosystem.

Virtually all key stakeholders and institutions in the industry are involved in multiple skills and training initiatives. These stakeholders range from manufacturers and dealers to consultants, trade unions, educational institutions, segments of the aftermarket, and employer and consumer associations. Their collective solutions are well-grounded in the

realities of the auto services industry, helping to resolve various problems as they arise. Indeed, what is especially remarkable is how many different stakeholders are taking up, in their own ways, similar challenges. Moreover, most actors—including businesses and employers' associations—are convinced that individual and market-based strategies cannot easily overcome the difficulties that they face. This insight has partially confirmed our initial expectations: to be employed effectively, skills and their development must be understood in their particular context (i.e., not as a generic plug-and-play strategy for national skills development).

Skills are also collective goods that are curated over time, resulting in "skills settlements," which are the product of industry actors and institutions interacting over many years. Even if many initiatives, by necessity, are targeted to particular groups of workers or occupations, there is also a common conviction that the industry requires sector-wide strategies in which multiple actors and institutions are moving in the same direction. However, it is uncertain to what extent these coordinated initiatives can provide long-term solutions to challenges in the industry.

Some initiatives pursued by particular businesses are genuinely innovative, but there is a lack of evidence and analysis about their effectiveness in the context of a larger strategy. Resulting from extensive social dialogue and stakeholder collaboration, the institutional strategies pursued by both the *comités paritaires de l'industrie des services automobiles* (CPAs) and the Comité sectoriel de main-d'oeuvre des services automobiles (CSMO-Auto)[1] offer more collective purchase in meeting some of the most pressing skills issues. Yet these strategies are also often patchwork, with a complex system of ad hoc state subsidies that often have short-term contracts and are tightly targeted to particular segments or regions in the industry. It would seem that new solutions need to be more systematic and province-wide, while also being grounded in the initiatives of relevant stakeholders.

These steps, though significant, are only the beginning of new developments in the auto services industry. Skills requirements are changing so rapidly that stakeholders will be compelled to engage in much experimentation for workers to keep up with the technology. Among the key requirements will be more comprehensive and enhanced initial training and a robust system of continuing education available to all workers, irrespective of their initial training and their degree of qualification. There is much evidence that new skills settlements are currently being established, but for these strategies to succeed, the industry requires a stronger impetus and greater coherence to increase its overall effectiveness.

1 CPAs are parity committees in which both employers and unionized workers are equally represented with an independent secretary and staff. CSMO-Auto is a multi-stakeholder sectoral council focused on labour market development and training issues in the Québec auto services industry.

Introduction

Motor vehicles are integral to how Canadians move around. The number of registered motor vehicles on Canadian roads has increased steadily over the past two decades, with over 35 million vehicles in 2018. This form of mobility features in the lives of most Canadians. According to the 2017 household survey (Statistics Canada, 2018a), 84% of Canadian households owned or leased a motor vehicle (94.9% in rural areas, 79.0% in cities with populations of a million or more), which means that these households are also concerned with the maintenance and repair of these vehicles. Moreover, this same survey indicates that expenditure on private transport was the second-most significant category for household expenditure (17.9%)—greater than expenditure on food (13.4%) and exceeded only by housing (29.2%).

Major advances in technologies are transforming the design, connectivity, maintenance, and repair of motor vehicles. Vehicles are now integrated systems of sensors and computers. This has major implications for access to the technologies embedded in these vehicles, as well as skill sets required for their maintenance and repair. The difficulties involve ensuring that workers in automotive services have the skills to service these new generations of vehicles, and that the necessary training reflects these technological transformations.

Furthermore, and of increasing policy relevance, the issue is not simply a question of the availability of the requisite services for maintenance and repair, but also of ensuring public safety in light of the technologies now embedded in the new generations of vehicles. Motor vehicles increasingly feature advanced driver-assistance systems (ADAS) that make automatic adjustments while driving (e.g., camera-guided parking assistance and vibrations felt on steering wheels for lane changes without proper signalling). These vehicles are demonstrating autonomous capacities that will accelerate significantly in coming years, making significant new demands on public infrastructure. Failure to ensure the proper calibration of such technologies is liable to have catastrophic consequences for road safety. The maintenance and repair of such systems will be an increasing feature of public policy debates—likely to be amplified in cases of accidents linked to deficiencies in the mechanical and digital performance of autonomous vehicles.

Since cars and trucks are also one of the major sources of greenhouse gas (GHG) emissions, the auto industry is at the centre of debates about sustainable development and about how to achieve Canada's international commitments to reduce climate change. New generations of vehicles powered by hybrid, electrical, and hydrogen engines will be the focus of continuing policy initiatives over the next decade. Indeed, in a major policy initiative, the Government of Québec has become the first provincial government to announce its intention to ban the sale of gas-powered cars and SUVs by 2035 (Lowrie, 2020). Manufacturers are engaged in frenetic innovation to outpace their competitors in the race to bring these new vehicles to market. This is translating into the sales of new vehicles that are rising rapidly in popularity, although still a small overall proportion of vehicles on the road as of 2020 (see Figure 5). Stock market valuations—such as the ascension of Tesla as the most valuable auto manufacturer listed on the stock market (Stevenson & Bloomberg, 2020)—are yet a further indication of this trend.

This has multiple ramifications for skills requirements in the auto services industry, where most workers have been trained on internal combustion engines. According to most industry stakeholders, their workers are not fully equipped to deal with these new generations of vehicles. Future skills in automotive services will certainly involve "green skills"; however, as in many other industries, the question is: will automotive services be ready for this green future, given the ongoing disruptions provoked by the development of these new technologies?

Future skills in automotive services will certainly involve "green skills"; however, as in many other industries, the question is: ***will automotive services be ready for this green future****, given the ongoing disruptions provoked by the development of these new technologies?*

This paper tells a story of technological disruption and its multiple impacts on the downstream segments of the automotive industry, specifically motor vehicle or "auto" services. The focus is on how this industry is dealing with these disruptions and their implications for our thinking about skills training.

The auto services industry provides a good illustration of how technological change is impacting a fairly traditional industry, in which the skill base is not necessarily where it needs to be and the basic and lifelong training systems show several gaps. This study examines auto services in Québec, with a focus on the auto service technicians (primarily mechanics) who ensure the maintenance and repair of motor vehicles in dealerships, as well as aftermarket services for those vehicles.

The industry faces several key problems. First, it has been characterized by ongoing skills shortages, where employers are in competition for just about anyone willing to work in their industry. Second, there are significant skills gaps, with technological innovations outpacing the capacity of workers in the industry to keep up with them. Third, since the majority of its workers have lower educational attainments—many workers have not completed high school—the auto services industry provides a case study of how technological change poses steep challenges for skill acquisition and appropriate training systems. Fourth, the transition to sustainable vehicles is likely to exacerbate these challenges, as the industry deals with the pressure of adapting rapidly to reduce its impact on climate change. Fifth, small and medium-sized employers (SMEs) predominate in this industry, which highlights a training trap for SME employers who are often characterized by lack of resources and poor human resource practices and who are reluctant to train workers who might go elsewhere once they are better trained. Finally, several stakeholders have emphasized the severe difficulties in devising effective training systems that can enable employees to experiment and find solutions to industry problems. In short, the industry faces a perfect storm when it comes to the development of future skills.

Québec is of particular interest because it presents one of the most elaborate ecosystems in skills and training for auto workers among Canadian provinces (Charest, 1999; Sharpe & Gibson, 2005). This skills ecosystem involves a range of institutions and actors engaging in ongoing dialogue, undertaking a range of experimentation and innovation to solve some of their problems. We believe that it is important to highlight how these institutions and actors are seeking to deal with technological change, including the innovations they have put in place to determine what can be learned from this transitional experience. As recently argued by the International Labour Organization (ILO, 2020), the skills challenge "in the current context of transformative global economic and environmental change requires a reinvigoration of the social contract through strong tripartite social dialogue" (p. 14).

Exploring Skills Through an Industry–University Research Partnership

The analysis developed in this paper grows out of ongoing exchanges with industry partners and stakeholders. In order to develop a comprehensive portrait of an industry in flux, our study involved in-depth interviews with an extensive range of stakeholders and representatives (n=105) in all segments of the auto services industry in the province of Québec. The focus has been on identifying technological change and exploring its impact on business models, skill requirements, training challenges, and industry innovations in skills and training.

Technological Change and Skills

The auto services industry illustrates many of the most persistent problems in the provision of skills and training in an era of digital transformations. These include significant technological changes, with multiple implications for business models and their required skills, which in turn place huge pressures on skills ecosystems (i.e., how the necessary skills are produced in particular industries and regions).

First, the automotive industry is experiencing *transformative technological change*. In the European Union—from a recent Eurofound overview of game-changing technologies in the digital era—two of the eight most transformative technologies are directly linked to the auto industry: the advent of electric vehicles and the development of autonomous driving systems (Eurofound, 2020). A subsequent section of this paper will focus on the impact of these technologies in more detail; as such, in this section, we will only briefly highlight how these changes are continuous, transformative, and disruptive.

Second, the auto services industry provides an apt illustration of *how these new technologies are transforming, as opposed to eliminating, jobs*. Many observers tend to associate the digital revolution with threats of massive job loss; however, the reality often involves shifting the content of jobs and modifying the nature of tasks (Organisation for Economic Co-operation and Development [OECD], 2019). Manufacturing and services are transformed by the intermixing of robots and humans in complex systems, which can lead to the elimination of jobs as well as the creation of new ones (Carré & Tilly, 2020). Additionally, services are being transformed by the nature of the technologies embedded in the products they service. The role of automotive technicians offers a telling illustration of this phenomenon: since the vehicles they service are now characterized by the technologies embedded in them, it is increasingly difficult to maintain and repair them without recourse to diagnostic applications. These tasks now demand a thorough understanding of the electronics underlying these products, in which most of the technicians (once labelled "mechanics") have not been trained. Indeed, the skill set traditionally required to perform repairs and maintenance was mainly focused on physical and mechanically-oriented tasks, whereas the recent technological changes in vehicles require more intellectual, digital, computer, and problem-solving skills than ever before.

Third, technological change is transforming the way that businesses operate, leading to *disruption in business models* with consequent challenges for the adequacy of skill sets (World Economic Forum, 2016). The "business model" refers to how organizations create, deliver, and capture value through their activities in order to generate surpluses (Storey & Salaman, 2008; Savolainen & Collan, 2020). In this section, we will discuss the advent of the "digital economy," providing several examples of how technology has affected traditional business models and ushered in new innovations. For instance, business models for retail distribution have drastically reduced reliance on brick-and-mortar stores in favour of digital services—Amazon being the paramount example. Ride-hailing applications such as Uber and Lyft, resulting from so-called "disruptive technological transformations," contribute to the emergence of new ways of organizing urban mobility. In contrast to the fleets of the traditional taxi industry, companies like Uber and Lyft have experimented with business models that capture value in new ways. In automotive services, companies like Tesla are using online distribution to reduce—and even eliminate—the role of classic intermediaries, such as car dealerships, by transacting directly with the consumers of its vehicles. Changes in modes of propulsion will have a profound impact on transforming business models in the auto services industry, causing its classic services, such as oil changes and muffler repairs, to largely disappear.

Technology is certainly important, but it is not the only factor under consideration. Its impact must be understood through its relation to the organizational structure of businesses and the skills and capabilities required by both workers and management to successfully maintain operations. For Applegate (2000), this requires a closer look at the concept (the opportunity and strategy), the capabilities (the resources to execute the concept), and the value proposition (the benefits for investors and other stakeholders). More recently, Armour and Sako (2020) point to three specific dimensions of business models: 1) the human capital and human resource practices (capabilities and skills, as well as compensation and promotion systems for motivating and incentivizing personnel); 2) the availability of capital to acquire technologies and invest in R&D; and 3) the organizational governance structure (how decisions and policies are made). For the purposes of this analysis, we are particularly interested in the capabilities required to conduct the business: those specific skill sets necessary to maintain the business as a going concern (i.e., a viable business). In automotive services, similar to several other industries, skills cannot be considered in isolation from the ways in which business models are changing.

Fourth, as business models are transformed by technological innovations, a key competitive factor concerns *the skill sets required* and their availability. Storey and Salaman (2008) highlight a fundamental tension that informs the conditions for success and failure: that between the competitive positioning of an

organization's business model, and the skills and knowledge required to exploit that model. Success requires a dynamic alignment of those knowledge-based requirements and capabilities with the model. The value proposition of traditional and emerging models is critically affected by the organizational capacities and employee competencies of individual businesses, which has been identified as a major challenge in the context of rapid technological change (Rachinger et al., 2019). Some countries, such as Germany, are recognized for their high level of achievement in manufacturing innovations and exports—a model which is supported by a sophisticated training infrastructure (Culpepper and Finegold, 1999). In other words, economic performance depends on high levels of skill as well as the ability to maintain and develop those skills. In the auto services industry, it is difficult to imagine occupying a niche in the emergence of new generations of vehicles if businesses struggle to access the skills required to service these vehicles. Thus, the issues of skills development and competencies are deeply embedded in the success of business models amid technological change.

Fifth, it follows that digital transformations are not only affecting the skills that employers require but are also reducing the longevity of employees' existing skill sets (World Economic Forum, 2016). This raises the question of the nature of skills necessary in these new technological environments. In a 2019 report, the OECD emphasizes that workers "need more than digital skills to adapt to these changes" (OECD, 2019, p. 22). Attention must be focused on understanding the proper mix of skills and how some skills sequentially lead to others. The OECD identifies a range of such skills: strong general cognitive skills (e.g., literacy and numeracy), ICT skills (e.g., basic and advanced such as coding), analytical and complementary skills (e.g., problem-solving, creativity, and critical thinking), communications skills, and a strong ability to continue learning. As argued in the OECD report, it is the mix of literacy, numeracy, and problem-solving skills in technology-rich environments that truly unlocks the benefits of these new technologies (OECD, 2019). While many focus attention on the availability of STEM-related knowledge and skills, they ignore the underlying foundational skill sets required for this new generation of technological change—a trend of which many industry actors are acutely aware, as discussed further in this report. An important skills gap has arisen in two ways: 1) workers often do not have the technical skills required to operate new technologies (Saunders et al., 2020); and 2) it is often difficult for workers to acquire those technical skills, due to a lack of foundational skills such as numeracy and literacy, which are most often the building blocks to develop other essential skills (OECD, 2019, p. 12).

Sixth, there is the critical question of where and how these necessary skills are to be acquired. This highlights three basic problems for training ecosystems. The first problem is one of "free riding" which denotes opportunistic behaviour around skills acquisition in competitive markets (Crouch, 2006). Some employers invest significantly in training and then lose the employees in whom they have invested to other employers

who have not made such investments. The prevalence of free riding creates reluctance among employers to invest in training. In the auto services industry, employers often express their reticence to invest in skills upgrades because such training may provide an opportunity for other employers to raid their best employees or inspire their workers to ask for an increase in wages.

The second problem is that the solutions to most skills acquisition issues are systematic and collective. Therefore, skills must be considered as collective goods, aiming to make investments in training valuable at the industry level while reducing free riding tendencies, rather than having skills acquisition remain limited to the whims of individual business choices. For previous generations of technological change, it has often taken decades to build the training or skills ecosystems needed to develop new skill sets. Yet many employers and other observers seem to be proponents of "magical thinking," as they have traditionally been what the World Economic Forum (2016) labels "passive consumers of ready-made human capital" (p. 29). In other words, by posting a job advert, the world will magically produce the skills that prominent employers need—relying on governments, education systems, and labour markets to supply skilled (and scarce) labour to upgrade their skills and maintain their competitive advantage. The impacts of digital transformation thus emphasize that governments and businesses will likely have to change their approach to education, skills, and employment, making larger investments of time and energy into workforce development (World Economic Forum, 2016).

The third problem is one of renewing traditions of social dialogue around best practices in skill development to support both employers and employee representatives who would significantly benefit from upgrades to employee skill sets, both "through gains in productivity, efficiency, and business innovation" and "through improved organizational culture, employee motivation and reduced staff turnover" (ILO, 2020, p. 14).

A final observation concerns the role of industry actors in building and sustaining skills ecosystems. Buchanan et al. (2017) argue that skills can only be understood in the context in which they are developed and deployed, with different industries and regions reflecting what has been labelled as "skills settlements" between a variety of actors and their interests (p. 459). This refers to the nature of skills produced: by whom, for whom, and by what means. It also points to the need to drill down on particular skill sets and their evolution in specific contexts. From this perspective, we have much to learn from a detailed analysis of industries and regions in terms of how they are dealing with skills challenges in the digital era. It is essential to understand both how these ecosystems are being disrupted by new technologies and other factors and how and why various actors seek to adapt the institutional configurations or skills settlements in which they have long invested their energies. For example, when an ecosystem is not producing the new skills required, various actors need to be convinced that some other arrangement—such as more constraints on the behaviour of individual firms—could produce better

results. Such arrangements are likely to be the result of ongoing choices made by various actors who are directly concerned by and dealing with these issues. Lloyd and Payne (2002) also emphasize that there are often variable solutions available. For example, in her comparative study of call centres, Batt (2000) found significant variation in services, with mass-produced, standardized services being sustained by lower levels of skill, as opposed to individualized customer services that require more complex, higher levels of skills.

Several factors are critical to understanding the work organization and levels of skills required within a given business model, including power relations within and between firms, institutional strengths and weaknesses, and the ability of actors to engage in collaborative solutions to industry-level problems. In that regard, the auto services industry provides a good example of these tensions and the impact of ongoing choices, as it is characterized by a variety of actors with competing business models attempting to craft their own narratives and skills settlements. Overcoming these tensions is a challenge that must be considered as a long-term initiative at the sectoral level, as individual efforts are typically only effective over the short term.

Instead of examining more broad-brush solutions, the literature on skills acquisition and our analysis of input from stakeholders have oriented this study toward a deeper dive into specific skill sets (those needed by auto technicians) in a particular industry (auto services) in a particular Canadian region (the province of Québec). In this respect, we have greatly benefited from the insights of many industry partners in an ongoing collaboration with the main industry body in Québec, as well as our primary partners—in particular, the Comité sectoriel de la main-d'oeuvre des services automobiles (CSMO-Auto), a multi-stakeholder sectoral council in the Québec auto services industry that federates a wide range of industry actors around skills and training issues.

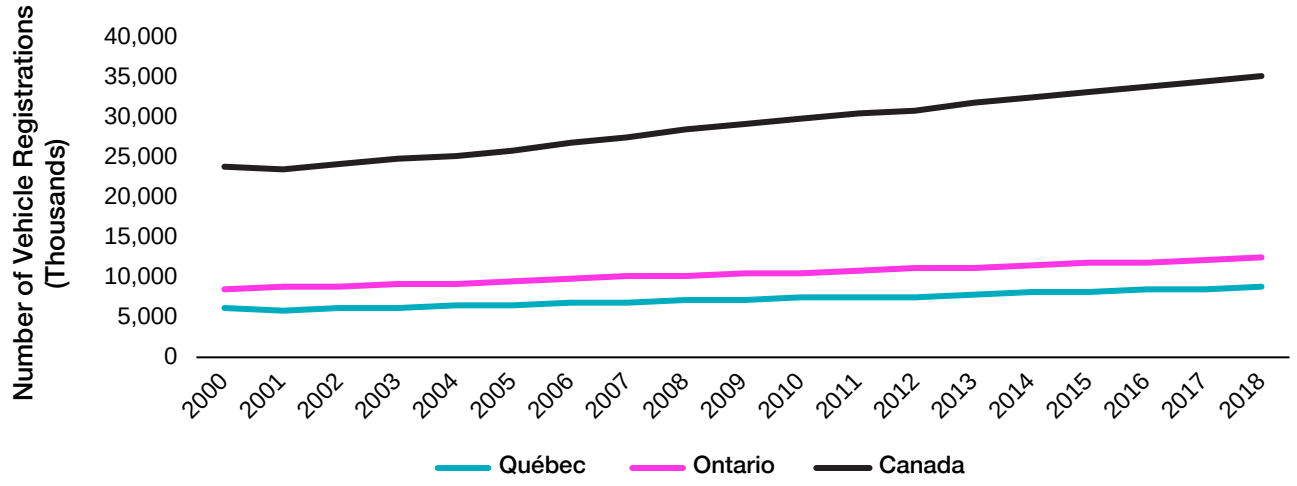
To understand these skills challenges, it is important to give an overview of the auto services sector, the technological changes arising from innovations in cars and parts, and their implications for the dynamics throughout the value chains of the industry—from the production of vehicles and their sale to consumers, to the maintenance and repair of these vehicles once sold. The interplay between technology and business models can explain, in large part, the consequences for skills and training in the workplace. As we will explore in subsequent sections, for the Québec auto services industry to successfully face these challenges, new forms of dialogue and training initiatives must arise between key actors. There is much to be learned from these ongoing efforts by industry actors to meet the challenges they face.

An overview of the auto services industry in Canada

The automotive industry is a major feature of the commercial landscape in Canada. The number of registered vehicles has been steadily increasing over the last two decades (see Figure 1). The industry is also a major source of employment, as employment growth across Canada (see Figure 2) reflects the progression in the number of vehicles.

FIGURE 1

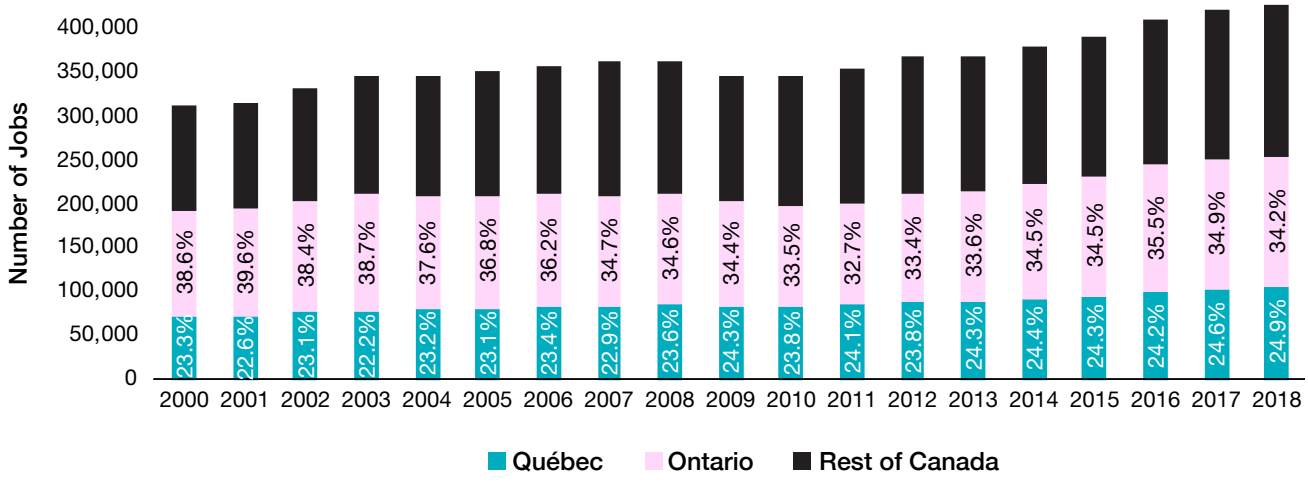
Total vehicle registrations in Canada, Québec, and Ontario (2000–2018)



Source: Statistics Canada (2020a).

FIGURE 2

Employment in the automotive services industry in Canada (2000–2018)



Note: The number of jobs includes both employee jobs and self-employed jobs.

Source: Statistics Canada (2020b).

TABLE 1

Number of employees in the automotive industry (automotive services and automotive manufacturing) in Canada (February 2020)

Automotive Industry (by NAICS code)	Employees	Percentage within Sector	Percentage within Industry
Automotive services (total)	**402,599**	**100%**	**75.6%**
Motor vehicle and motor vehicle parts and accessories merchant wholesalers (415)	**63,827**	**15.9%**	
Motor vehicle merchant wholesalers (4151)	24,086		
New motor vehicle parts and accessories merchant wholesalers (4152)	37,221		
Used motor vehicle parts and accessories merchant wholesalers (4153)	2,520		
Motor vehicle and parts dealers (441)	**224,743**	**55.8%**	
Automobile dealers (4411)	160,999		
Other motor vehicle dealers (4412)	23,036		
Automotive parts, accessories, and tire stores (4413)	40,708		
Automotive repair and maintenance (8111)	**114,029**	**28.3%**	
Automotive manufacturing (total)	**129,965**	**100%**	**24.4%**
Motor vehicle manufacturing (3361)	40,891	31.5%	
Motor vehicle body and trailer manufacturing (3362)	14,879	11.4%	
Motor vehicle parts manufacturing (3363)	74,195	57.1%	
Total employment in automotive industry	**532,564**		**100%**

Notes: Figures in brackets represent NAICS codes. Data from February 2020 predate the effects of the COVID-19 pandemic on employment.

Source: Statistics Canada (2020c).

The automotive industry consists of upstream manufacturers (i.e., vehicles and parts) and downstream auto services (i.e., wholesale distribution, retail distribution and servicing, and aftermarket maintenance, repairs, and associated services). While policy attention often focuses on the upstream—supporting the high value-added segments in automotive manufacturing—the downstream segments of the industry in automotive services are in fact a very significant source of jobs in Canada. Jobs in the automotive services industry include wholesaler-distributors, vehicle dealers, and repair and maintenance workers (see Table 1; Statistics Canada, 2020c). In February 2020 (the most recent point of observation before the effects of the COVID-19

TABLE 2

Employment in the automotive services industry in Canada, Québec, and Ontario (1998–2018)

Region	Sub-Sector in Automotive Services Industry (by NAICS code)	1998	2008	2018	Change 1998–2018
Canada	Motor vehicle and parts wholesaler-distributors (415)	56,020	50,420	65,285	17%
	Motor vehicle and parts dealers (441)	140,365	196,410	229,910	64%
	Automotive repair and maintenance (8111)	99,810	116,245	140,810	41%
	Total	**296,195**	**363,075**	**436,005**	**47%**
Québec	Motor vehicle and parts wholesaler-distributors (415)	13,175	13,505	16,275	24%
	Motor vehicle and parts dealers (441)	32,475	46,050	53,820	66%
	Automotive repair and maintenance (8111)	23,685	26,210	35,630	50%
	Total	**69,335**	**85,765**	**105,725**	**52%**
Ontario	Motor vehicle and parts wholesaler-distributors (415)	20,615	16,190	25,860	25%
	Motor vehicle and parts dealers (441)	54,875	69,040	81,610	49%
	Automotive repair and maintenance (8111)	37,630	40,345	48,010	28%
	Total	**113,120**	**125,575**	**155,480**	**37%**

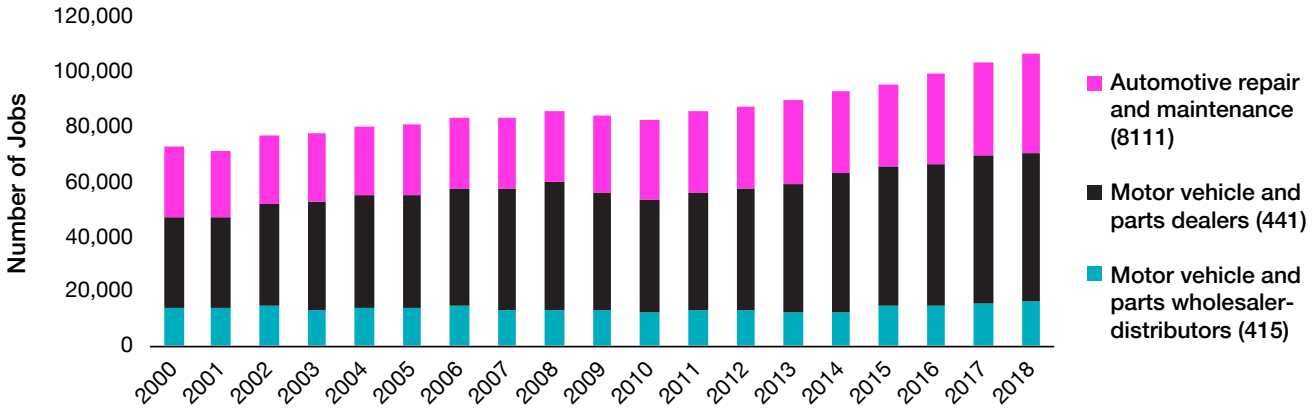
Source: Statistics Canada (2020b).

pandemic on employment were felt), 129,965 persons worked directly in motor vehicle manufacturing (assembly and parts), whereas automotive services (including parts distribution, dealerships and repair and maintenance) accounted for 402,599 employees. In other words, for every job in motor vehicle manufacturing, there were more than three in automotive services.

Employment in downstream auto services has also seen consistent growth. As reported in Table 2, which provides an overview of employment over the last two decades, job growth in this sector was 47% in Canada from 1998 to 2018, with provincial job growth of 52% in Québec and 37% in Ontario during the same period. The Ontario automotive sector employment showed a faster growth in the second decade, from 2008 to 2018, while employment growth in Québec was comparable over the two decades. There was also some variation between sub-sectors, with stronger growth among motor vehicle and parts dealers relative to other sub-sectors. The basic structure of auto services has remained quite stable over the last two decades—half of all jobs are in dealerships, one-third in the aftermarket, and one-sixth in parts distribution.

FIGURE 3

Employment in the auto services industry in Québec (2000–2018; by NAICS code)



Source: Statistics Canada (2020b).

A significant proportion of the labour force in automotive services is made up of two occupations: automotive service technicians, truck and bus mechanics, and mechanical repairers (7321)[2] and motor vehicle body repairers (7322). According to our calculations, based on data from the 2016 Canadian Census, between 42% and 43% of all employees in automotive services were engaged in these two occupations.[3] In other words, these two occupations constitute the core labour force in auto services. The availability of qualified workers in these two occupations (i.e., their skill profiles and access to training) is a significant challenge for industry stakeholders and policy makers—as we shall see throughout this report, skills shortages and skills gaps for these occupations are a pressing, ongoing concern. Thus, in this study, we focus our attention on this group of workers.

2 These codes relate to the National Occupational Classification (NOC) system (Statistics Canada, 2016).

3 See Appendix A for more detail on the data source and computation of these percentages.

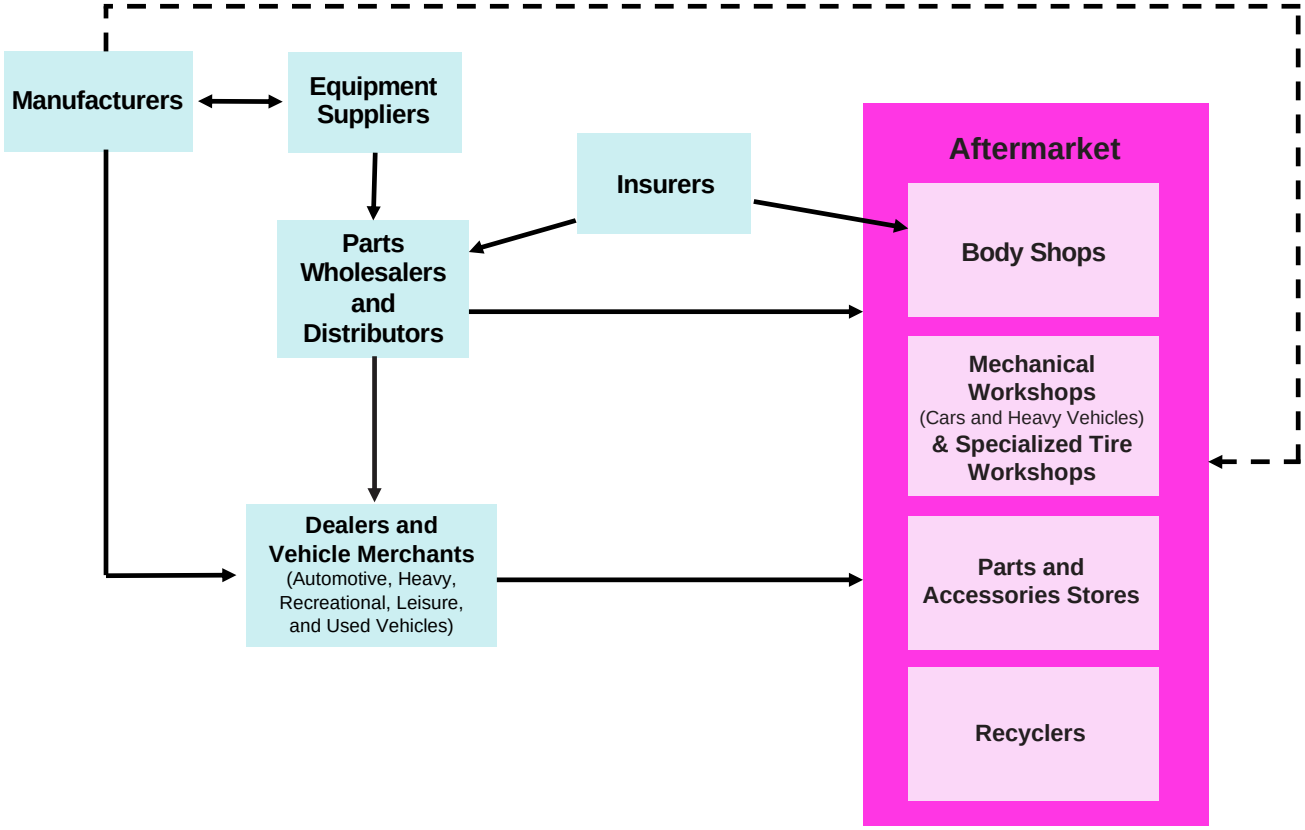
The anatomy of the industry

Our focus is on the downstream components of the industry, namely, those businesses providing services directly to consumers. Since many of the initiatives considered here concern automobile mechanics in different segments of the industry—one of the most significant sources of skill shortages and gaps—there is a particular (but not exclusive) focus on this trade throughout this report. As such, it might be considered a "mechanic-centric" view of the industry, which is understandable given the importance of this occupation in the auto services industry.

The upstream manufacturing components of the industry do not generally provide direct services to consumers for the vehicles and parts they produce. Rather, the upstream manufacturers operate through intermediaries such as dealerships and parts distributors—although this has the potential to change, as the cases of Tesla (for vehicle sales) and Amazon (for vehicle parts) both illustrate. Yet even if they do not directly own the dealerships or body

FIGURE 4

Anatomy of the automotive industry in Canada



Source: Created by authors.

shops, original equipment manufacturers (OEMs) and parts manufacturers do provide training to technicians, as they are directly concerned with the quality of the work that is performed under their warranties to consumers. Moreover, as we will see below, the upstream segments of the industry have a decisive impact on technological change in the industry as a whole.

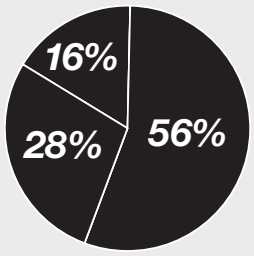
The different segments of the industry are highly interdependent. The most thorough way to understand the impact of technological change and other sources of disruption is by examining how they affect business models and skills challenges in different segments of the industry. We shall explore these topics in the next section, after providing a quick overview of the anatomy of the key segments of the automotive industry as well as the links between them.

Figure 4 presents a schematic overview of the auto services industry. It is a complex ecosystem characterized by strong interdependence, as well as intense competition between and within segments. Yet it also involves multi-faceted collaboration in terms of innovation, information exchange, and consultation between the actors.

*The **downstream auto services industry** is divided into three segments:*

***Wholesalers** for motor vehicles, parts & accessories*

Aftermarket**/automotive **repair & maintenance



*Motor vehicle & parts **dealers***

% of employment in auto services in Canada

An understanding of manufacturers is an essential first step for examining the dynamics of auto services. Manufacturers set prices and establish with their networks of dealers the conditions for the warranties offered on their products. Manufacturers also exert an outsized influence on the technologies in the vehicles and parts they produce, establishing the rules of the game with regard to intellectual property, including, notably, the conditions under which other businesses can access the codes and systems embedded in their products. Parts suppliers provide original equipment to vehicle manufacturers, while also competing with them to supply replacement parts (most frequently at a lower price). It is typically the manufacturers—themselves subject to lively competition between a proliferation of different brands and models—who set the context for the downstream auto services industry. They thus have conflicting interests: although their goal is certainly to sell vehicles and parts (their main sources of profit), they are also concerned by the work that is performed in the shops, as they have a financial stake in the cost of repairs and maintenance under warranties, as well as a reputational stake with regard to future consumer purchases.

The downstream auto services industry is divided into three segments (see Table 1 on page 10). First, there are the *wholesalers* for motor vehicles, parts, and accessories (15.9% of employment in this sector in Canada). Over many years, they have built up the means to provide the necessary parts, almost instantly, and to undertake repairs on motor vehicles. These wholesalers maintain complex distribution networks to ensure availability and continuity of supply for these parts.

Second, motor vehicle and parts *dealers* account for the largest proportion of employment in auto services (56%). The vast majority of these jobs are with automobile dealers. They are typically in direct relationships with manufacturers and—in addition to varied repairs—will do the work guaranteed by vehicle warranties (e.g., on vehicles sold or leased to consumers and on product recalls). The dealers tend to work almost exclusively on the brands in which they are specialized.

The third segment is the *aftermarket*, also labelled "automotive repair and maintenance," which accounts for 28.3% of employees in auto services. The aftermarket includes independent garages, franchises

operating under a common banner, and chains, who offer a wide range of services to maintain and repair cars (e.g., tires, exhaust systems, windshields, or more general repairs). There is a myriad of businesses in this segment, ranging from large, specialized garages in urban centres (e.g., tire retailers) to small family businesses that can employ one or two technicians (e.g., a general-maintenance garage in a small rural town). Their particular focus is on vehicles no longer under warranty, though consumers can always exercise personal choice, even when vehicles are still under warranty, by favouring the aftermarket for more competitive pricing of basic maintenance. In contrast to dealers specializing in a particular brand (e.g., Honda, Subaru, or Chrysler-Fiat), the aftermarket tends to work on multiple brands, unless they have chosen to specialize in a particular sub-set of such brands (e.g., German or Japanese vehicles). There is a competitive dynamic governing the relations between this aftermarket and the vehicle and parts dealers.

This study concerns these latter two segments: the aftermarket and vehicle and parts dealers, which collectively account for 84.1% of employment in auto services. From the perspective of skills and training, they draw on the same reservoir of skills for auto technicians or mechanics. They compete both within their market segment (i.e., other businesses in their segment) and between market segments (i.e., between dealers and the aftermarket). In other words, in terms of their basic business models, car dealers are competing with other dealers as well as the aftermarket for the provision of skilled labour. Moreover, it is in these two segments that auto service technicians and car body repairers are concentrated, accounting for roughly half of all jobs.

The relationship between these two segments of the industry is an important key to understanding the industry. According to the traditional business model for dealerships, their most lucrative activities were once associated with the sale of new vehicles, a model premised on the extraction of value from the sales of new vehicles. Maintenance and repair of these vehicles were described as “a necessary evil,” associated with fulfilling obligations on vehicle warranties. The role of maintaining and repairing the new vehicles beyond the life of these warranties was more typically associated with the aftermarket, as were repairs for used vehicles (e.g., those traded-in upon purchase of new vehicles) also sold by dealers.

Other kinds of dealerships also account for employment in this segment of the industry. Heavy vehicles such as trucks require specialist technicians and often have to compete for their services with other industries (e.g., construction, mining, oil and gas, and public transportation authorities in urban centres). Two other speciality segments are recreational vehicles (e.g., mobile homes and trailers) and leisure vehicles (e.g., snowmobiles, watercraft, motorcycles, and all-terrain vehicles), which draw on some of the same types of auto technicians; however, to date at least, these segments are less impacted by the most pervasive technological changes affecting the auto and truck sectors. The requirements in technology are less intense, occupying a niche market in the industry.

Reflecting the wide variety of repair work, the aftermarket is made up of multiple types of businesses—ranging from tire and lube specialists to mufflers, transmissions, and windshields, as well as more general mechanical workshops. These businesses may be independently owned, franchisees affiliated with a chain, or corporately owned.

The aftermarket also includes body shops, which focus on the repair of vehicles involved in accidents. Insurance companies interact constantly with these body shops, as their insurance policies cover some or all of the costs of repairs on vehicles involved in accidents. Insurance companies are increasingly focused on the standardization of prices and working rules, so that they can ensure the best price and value-for-money in repairs. These prices are determined on a provincial and industry level, through an official body, but tend to reflect the pressures enacted by insurance actuaries on reducing the profit margins of body shops. Over recent years, this has had a collateral effect of concentrating ownership in this sub-sector, as small independent shops have been wiped out by the need to make substantial capital investments in order to remain viable and to ensure their reputation with insurers. Since manufacturers also want to ensure that any repairs do not invalidate their warranties, some financial institutions and insurers are now branding their own evaluation centres—directing their clients to repair shops where they can better monitor quality and cost controls.

Finally, given the increasing importance of environmental standards and recycling of end-of-life products, recycling centres are an increasingly important and profitable segment of the industry, with manufacturers being rated on the extent to which their products are being recycled (Straits Research, 2020).

Creative Disruption Along the Value Chain in Auto Services

Implications for business models and competitiveness

This section first considers some of the fault lines of disruption currently impacting the auto services industry. It then looks in more detail at the technological transformations underway. Finally, it discusses the implications of these disruptions for existing and emerging business models, as well as the competitive pressures they generate. These trends provide the backdrop for our understanding of the consequent skills and training challenges discussed in a later section (see page 29).

Fault lines of disruption and transformative change

A series of significant disruptions has greatly affected the industry over recent decades

Open borders and trade liberalization

Recent decades have seen a significant expansion of world trade, facilitated by international, multilateral, and bilateral trade agreements. There is growing access for vehicles manufactured outside of North America, while vehicle and parts producers are seeking to take advantage of their location strategies—typically through greater proximity to markets, lower labour costs, and the protection of tariffs offered by regional "free trade" treaties.

Financialization

The accentuation of financial pressures on the industry as a whole, particularly on relations between manufacturers and dealers, has been a significant factor in ongoing transformations. These pressures reverberate from one part of the industry to the other, as all actors seek to maximize their revenues and minimize their costs. A major event was the 2008 financial crisis, during which the major auto manufacturers relied on government support to avoid bankruptcy and have since struggled to return to profitability. Further pressures flow from high levels of consumer debt, requiring ever-more ingenious strategies to finance consumer purchases.

Demographics and patterns of consumption

An aging population places considerable pressure on the labour force, especially outside of urban centres. In North America, household debt favours leasing, rather than the outright purchase of new vehicles, which forms an increasingly important component of dealer business models. Finally, changes in consumer habits result in more volatility between models and brands from one year to the next. The industry is now selling to better-informed and internet-savvy clients who have, at least for younger city dwellers, less attachment to purchasing cars. Young adults in cities often favour alternative modes of transport, such as shared mobility through services such as ride hailing.

The COVID-19 pandemic

While the full impact of the COVID-19 pandemic is still unfolding, we anticipate that it will affect both the supply and demand side of the automotive industry. On the demand side, there has been a decline in discretionary spending by consumers—a category of household expenditure that can be compressed through delayed purchases in times of uncertainty. In the period from April to August 2020, new vehicle sales declined by more than 300,000 in Canada relative to sales in the same period in 2019 (Statistics Canada, 2020d). This raises the question of not only the immediate impact on manufacturing, but also an across-the-board impact on mobility (McKinsey Center for Future Mobility, 2020). In particular, there are multiple implications for the aftermarket sector if consumers delay purchases of new vehicles and instead repair their vehicles, thus requiring more parts and maintenance from the aftermarket over the long term.

The auto services industry is now selling to ***better-informed and internet-savvy clients*** *who have* ***less attachment to purchasing cars and often favour shared mobility*** *services instead.*

On the supply side, disruption in global supply chains—especially for parts and components sourced internationally—may have long-term implications. The pandemic has exposed the risks of an over-reliance on foreign markets for manufacturing supply chains (Kilpatrick & Barter, 2020). This could lead to greater local sourcing of inputs and components, which could be a positive development for Canadian suppliers, unless US-based manufacturers draw similar conclusions and reduce their purchases of Canadian components.

Another supply-side effect emerges from the production and employment impact of lockdown measures. The lockdown in the spring of 2020 provoked massive disruption, with more than 300,000 manufacturing workers displaced from their jobs and production activities significantly curtailed.

While both employment and production recovered over the summer months, the resurgence of the pandemic through the autumn of 2020 and the winter and spring of 2021 again threatened recovery. A return to lockdowns sparked by new variants and rising infections could lead to significant skill displacement, as experienced workers take early retirement and younger workers seek employment in other industries. The experience of the 2008 financial crisis indicates that workers in the auto sector were absorbed by other industries such as trucking, warehousing, and construction—thus resulting in a permanent loss of skilled workers (Moffat, 2021). In addition, with concerns mounting about further health disruptions, the pandemic is likely accelerating the rate of automation already underway in the industry.

Climate change

Global warming and climate change are putting enormous pressure on the industry. Manufacturers are under multiple pressures to make the transition to new forms of propulsion, with lower GHG emissions through hybrid, electric, and/or hydrogen-powered vehicles (Hyundai and Toyota launched their first hydrogen models in 2013 and 2014). All of these producers are engaged in a frantic race to occupy these market niches, with huge outlays in capital investment for research and development of these new products. In Canada, Ford Motors has decided to make a major investment in its Ford Oakville facilities to produce electric vehicles (EV), resulting from an agreement with UNIFOR, the major union in the auto sector.

Environmental considerations are also translating into new regulatory structures, as Canada's climate change commitments require public policies to promote greener vehicles. British Columbia and Québec stand out from the rest of Canada, where provincial subsidies are added to federal subsidies for the purchase of such vehicles, translating into their dominance in the Canadian market for this type of vehicle. New environmental norms are only likely to increase. A good example is California's June 2020 requirement that half of all trucks sold by 2035 must be zero-emission, with this proportion increasing to 100% by 2045. In September 2020, California further announced that all new passenger cars and pick-up trucks sold in 2035 would have to be zero-emission. This follows a similar commitment for buses by 2029, with a commitment to make the entire fleet electric by 2035 (Tabuchi, 2020).

Such pressures are not unique to California and are now likely to receive much greater impetus with the election of Joe Biden—the Democratic candidate for president—in November 2020. For example, in a sign of shifting corporate strategies and a return to Obama-era environmental regulations, General Motors has recently dropped its opposition to California's carbon targets for vehicles (Davenport, 2020). Moreover, given the importance of the Californian market, these targets are expected to have an impact on the entire North American market, as have past emissions regulations enacted by the state (e.g., On-Board Diagnostics (OBD)-II requirements). The recent announcements of both Québec (November 2020) and the Government of Canada (June

2021) to adopt the same 2035 target for the sale of passenger cars and light-duty trucks illustrate the point of no return that the industry is facing. Other major corporations are also following this trend (e.g., Amazon's commitment to purchase 100,000 electric trucks and become a zero-emissions company by 2030).

All of these disruptions have multiple effects on the auto sector and the business models of its component segments, but it is first important to consider the impact of technological transformations on the industry.

Technological innovation in the auto industry: Computers on wheels

Technological change is driving the demand for new skills in multiple industries across the globe. The digital revolution is profoundly changing the ways in which vehicles and parts are produced (e.g., robotization), located (e.g., remote inventory control), delivered (e.g., inventory management), sold (e.g., online purchasing), validated (e.g., remote artificial intelligence applications), and repaired (e.g., scanning embedded codes with diagnostic applications). To understand the future skills and training challenges in the auto industry, it is crucial to understand how its technologies have changed over the long term.

While the automotive industry has long been characterized by the integration of different technologies and important technological innovations, the incredible pace of change now constitutes the real challenge for skills and training. Cars have transformed from primarily *mechanical-centred* products to *digital-centred* technologies. Our observations are informed by extensive contact with auto service industry specialists, who have directly experienced these different phases of change and with whom we have discussed these trends. As several of them emphasized: "A car today, it's a computer on wheels! No… several computers on wheels!"

Table 3 provides an overview of four generations of technological change and their implications for business models, labour and skills requirements, actors and institutions involved in the provision of training, and workforce/human resource strategies.

The first phase of change began in the 1980s as engines transitioned from carburetors to electronic fuel injection. This was a significant change, because electronic fuel injection systems required on-board computers, thus marking the movement from purely mechanical to electronic systems. For many workers who had mastered their trade on mechanical technologies, this disruption highlighted their first skills gap, as mathematical and electrical knowledge was increasingly required to work on these new systems.

A second phase of technological disruption appeared in the mid-1990s, with the obligation to equip all new vehicles with OBD-II in 1996. This was the initial manifestation of the climate crisis, as rules on GHG emissions in California required

TABLE 3

Phases and implications of technological change in the automotive industry

Phase	Technological Innovations	Business Models	Changing Skill Profiles	Workforce Challenges
Phase 1: 1980–1995	> Primarily mechanical: first computerization with transition from carburetors to fuel injection engines.	> Functionally operational division: dealers vs. aftermarket. > Predominance of profitable, family-owned businesses without huge injections of capital.	> Mainly mechanical skills on traditional combustion engines.	> Apprenticeships for school leavers on two tracks: initial vocational training and early leavers without that training; adequacy of labour supply.
Phase 2: 1996–2009	> Entry of OBD-II and manufacturer codes in vehicles; represents a major change with increasing presence of on-board computers and sensors.	> Proliferation of brands and models in the context of free trade, with increased competition and longer warranties. > Multiple dealerships by same owner to counter volatility. > Increased banners in aftermarket. > Non-specialist retailers (e.g., Walmart) enter aftermarket to attract customers.	> Still primarily mechanical. > New electrical and computer skills are often learned on the job (not always taught in vocational schools).	> Emergence of labour shortages. > More institutional innovation on skills issues (e.g., awareness campaigns and promotion of automotive trades) but with middling results.
Phase 3: 2010–2020	> Embedded patented technologies and computerization predominate. Emergence of telematics (i.e., vehicle info through telecommunications). > New modes of propulsion (i.e., hybrid, electric, and hydrogen vehicles).	> Financial crisis sparks manufacturer pressures on dealer profitability. > Concentration of dealer ownership. > “Right to repair” movement for aftermarket access to codes. > Increased durability of parts decreases repairs.	> Increased standardization of tasks (e.g., warranties and bodywork). > Code-based diagnostic skill and electrical knowledge needed for new modes of propulsion. > Increased recalls due to acceleration in new products.	> Loss of skilled labour to other industries, with greater pressure on wages. > Multiple retention and attraction strategies: companionship, immigration, financial incentives. > Skill gaps more evident in light of technological change.

Phase 4: 2020 and beyond (ongoing)	> Decrease in combustion engines. > Increase in autonomous driving technologies, telematics, and on-board computers. > Artificial intelligence. > Parts produced as needed through 3D printing.	> Spread of Tesla online model—no traditional dealer, and repairs by manufacturer service points. > Jockeying to eliminate role of competitors in other segments. > Shared mobility in urban areas. > Increased concentration and specialization in aftermarket. > Insurers use AI to control repair costs.	> Technological skills increase in importance; essential skills gaps are an obstacle to productivity in the workshop.	> Greater demographic pressures on recruitment and retention. > Necessary emphasis on training. Revaluation of the trade due to the need for training and skills. > Scope for new college-level training in diagnostics.

Source: Created by authors.

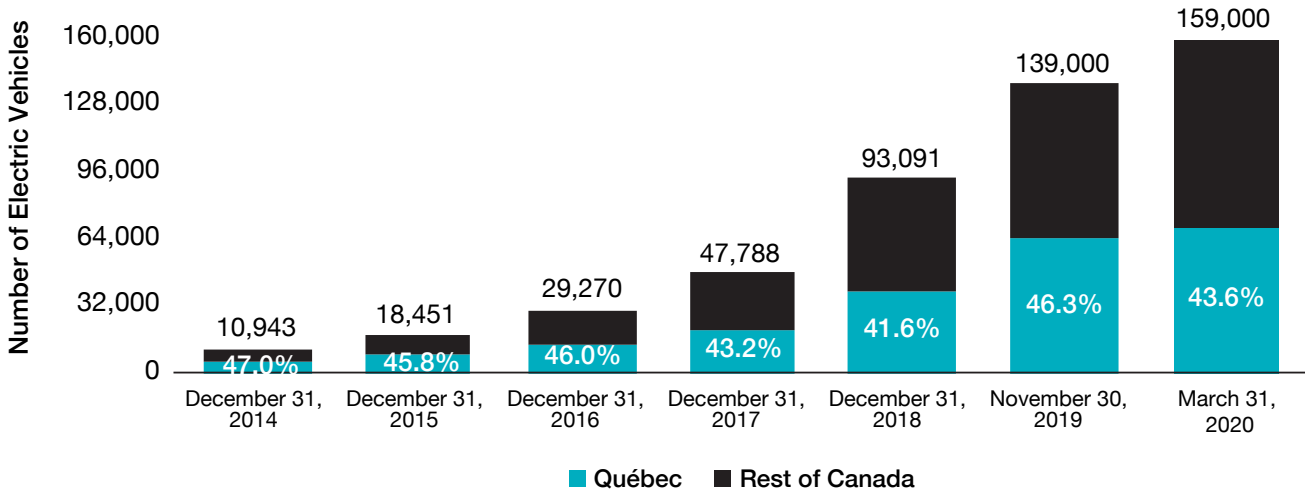
vehicles to monitor emissions and other information by plugging into a standardized system to perform environmental diagnostics. This technological change had four major impacts. First, it greatly accelerated the integration of different kinds of computers into vehicles to monitor these new systems. Second, it prompted the integration of different kinds of sensors into vehicle components, in order to communicate information with the OBD-II systems. Third, this phase of innovations further highlighted the transition from mechanical to electronic technologies and the need for workers to acquire new skills to service future generations of vehicles. Fourth, these technologies accentuated the divide between dealers and aftermarkets: OBD-II systems required access to manufacturers' codes and information to diagnose problems and undertake repairs. Branded dealers had easier access to these codes; however, access by businesses in the aftermarket was a more complex issue of proprietary technologies, intellectual property, and the ability of manufacturers to extract rent for their use in servicing vehicles. While many wholesale parts intermediaries offered bridging solutions, the issue of access—encapsulated by the "right to repair" movement in the United States[4]—highlighted the problems that independent garages and body repairers were having in effectively gaining access to these essential new technologies.

A third phase of accelerated technological change dates from 2010 with the advent of the "connected car" (McKinsey & Company, 2014b) and the emergence of new modes of propulsion. These technologies include the pervasive entry

4 The "right to repair" movement was established in 2014 as a nationwide agreement between automobile OEMs and independent car repairers, granting access to parts, tools, and diagnostics on "fair and reasonable terms." Many states have also adopted "Fair Repair" bills or "Right to Repair" acts (Svenson et al., 2018).

FIGURE 5

Evolution of electric vehicles in Québec and Canada (2014–2020)



Source: Electric Mobility Canada (2020) & Association des Véhicules Électriques du Québec (2020)

of information systems in motor vehicles and parts; assisted driving technologies; advanced diagnostics through increasingly complex manufacturers' codes; telematics for on-board continuous communications with vehicles; and alternative modes of propulsion including hybrid, electric, and hydrogen. The integration of these technologies affects various practical aspects of vehicle operation, maintenance, and repair. For example, the connectivity of devices inside vehicles permits the monitoring of usage and data management, as well as direct connection with consumers, independently of dealers who had previously always been the primary contact between consumer and manufacturer. As such, technicians and mechanics must now be able to handle the sale, maintenance, and repair of increasingly complex machines. The move from mechanical to digital skills means that virtually all operations require some degree of diagnostics and re-programming of the vehicle. Some traditional service activities, such as oil changes, have disappeared entirely for electronic vehicles. Another significant change includes online sales through which—the so-called "Tesla model"—the manufacturer can largely bypass traditional dealer networks through telematic monitoring and online distribution. Finally, insurance companies have also introduced new generations of technology, specializing in diagnostic algorithms for the evaluation and costing of repairs. These algorithms aim to reduce the scope for false claims by consumers while standardizing repair prices, thus limiting the traditional discretion of body repair workshops when undertaking the repair of damaged vehicles.

A fourth phase, from 2020 onwards, is more prospective. First, there are many uncertainties about which modes of propulsion are likely to predominate in coming years. While there is a consensus that the importance of the traditional internal combustion engine will decrease, it is not clear what combination of the hybrid,

fully electric, hydrogen, or some other technology will emerge as predominant in the market. Second, digital technologies will have a more important presence in vehicles, as autonomous vehicles are currently the subject of much innovation and experimentation. The extent of autonomous vehicle diffusion raises complex issues for public safety and civil liability, as well as multiple infrastructural requirements in the design and upkeep of roads. Third, it has become clear that new technologies account for an increasing proportion of value-added assets in motor vehicles. In a recent study, PricewaterhouseCoopers (2018) highlighted that future value-added in motor vehicles would most likely be linked to electronic systems of combustion and parts, as well as the integration of sensor and actuation systems in vehicle interiors and chassis. This can lead to reduced scope for repairs, as the replacement of high value-added parts (i.e., plug-and-play repairs) becomes the major proportion of revenue for manufacturers. Finally, shifts in consumer preferences and patterns of consumptions may lead to a large-scale restructuring of the automotive industry along the entire value chain. Individual cars are likely to remain dominant, but certain markets—notably in metropolitan areas—might alter patterns of consumption, as ridesharing and other collaborative transportation could be a game-changer for the industry in the context of ecological transitions. However, uncertainty continues to characterize these patterns as public health crises such as the COVID-19 pandemic can also prompt a return to the use of individual vehicles.

Disruption and transformation of business models

The fault lines of disruption—specifically, technological transformations—are changing existing business models and accentuating competition all along the value chain. In the auto industry, it starts upstream with manufacturers and works its way through the downstream segments in auto services (see Figure 4). Given the interconnectedness among different segments (e.g., between dealerships and the aftermarket), there are cascading effects on all actors in the industry.

Manufacturers

Rocked by the 2008 financial crisis, manufacturers (i.e., assembly and parts, OEMs, and replacement parts) have struggled to return to profitability while facing ever-greater pressure to innovate. Free trade and emerging markets have multiplied sources of competition and increased the use of transnational supply chains. The race to produce more eco-friendly vehicles exerts huge pressures to modify technologies, while also reducing cost. Manufacturer strategies to enhance returns on investments include increasing value-added in vehicle parts by integrating new connected technologies—which squeezes dealer margins on new sales—and by increasing emphasis on proprietary technologies to secure a greater share of aftermarket profits (Kempf et al., 2018). All of these strategies exert direct impacts on the organization of work and the skills required in auto services.

Dealers

According to the McKinsey Center for Future Mobility, automotive dealers are facing significant pressures on profitability, with a decline from a margin of 8.9% on sales in 2015 to 1.7% in 2018 and further decline likely in the absence of strategic adjustments (Inampudi et al., 2019).

Manufacturers still depend on dealers to get products to market; however, their ability to dictate the terms of this relationship allows them to pressure dealer profits and secure greater returns on investment from innovation. This includes squeezing margins on new vehicle sales, a greater role in financing and insuring sales (normally a source of dealer profits), more direct sales to fleets, tighter controls on post-sales work completed under guarantee, and more stringent requirements for showroom renovations and employee training.

The internet has also become a central feature of the dealer–customer relationship. Internet-savvy consumers research extensively prior to purchasing new vehicles, thus exerting competitive pressures through comparison shopping and greater pricing transparency. This trend has been exacerbated with the reduction of face-to-face interactions in the context of the COVID-19 pandemic. Technology is reshaping the role of sales consultants, including an emphasis on virtual showrooms and a seamless customer experience through technological interfaces (Inampudi et al., 2019). It is also possible to cut out the role of dealers entirely, with the advent of online sales and delivery of vehicles directly to consumers. Most worrying for dealers is the Tesla business model, which eliminates traditional dealers in favour of stores in suburban malls; Tesla tightly controls its technologies by offering purchases exclusively online and limiting maintenance and repair work to just a few certified shops.

For electric and hybrid vehicles, maintenance and servicing costs are estimated to be half of those for internal combustion engines (Inampudi et al., 2019). As electrical vehicles predominate, some repairs will disappear (e.g., oil changes) while others will become more important (e.g., battery maintenance). As explored in the next section, there are strong pressures on employees who have not been trained in these skills to service these new vehicles.

Dealers are therefore obliged to develop compensatory strategies. First, growing ownership concentration—whereby holding companies purchase multiple concessions with different brands—enables these larger entities to deal with variations in the popularity of products year over year, and provides some counterweight to the market power of the manufacturers. Second, with the pressure on new vehicle margins, maintenance and repair become more important, a strategic shift which necessarily dips into the profit pools of other downstream segments in the industry, such as the aftermarket. The aim of dealers is to enhance their relationship with customers through the sale of extended maintenance at the time of purchase, servicing beyond initial warranties, and routine services such as winter tires. Their recourse to telematics facilitates this customer relationship, e.g.,

regular and time-sensitive reminders for servicing. The effort by dealers to secure a greater share of maintenance and servicing profits clashes with their historical division of labour with the aftermarket, where the value proposition relies on lower-cost routine maintenance and servicing, particularly for those vehicles no longer under warranty. As we shall see below, the resilience and competitiveness of the aftermarket in seeking to build customer loyalty further complicates this strategy for dealers, especially where consumers emphasize cost and convenience.

The aftermarket

Technology is also disrupting aftermarket business models and skill requirements. The introduction of patented technologies and computer codes in new vehicles potentially weakens the competitive position of the aftermarket. As explained by one interviewee: "You cannot repair a vehicle without a scanner and access to the embedded codes!" These codes make vehicle diagnostics more complex and, as we shall explore in the next section, have multiple consequences for skills and training. Dealers' strong links with OEMs confer a natural advantage; whereas the aftermarket either needs to negotiate the cost of access to these embedded codes or secure public regulation in the name of consumer rights, such as with the "right to repair."

Telematics and the connected car are modifying the relationship between consumers and branded products. A recent survey suggested that six of ten consumers are likely to follow prompts for predictive maintenance at a suggested outlet or dealer. The question of who owns the data related to customers is a regulatory issue. Yet despite the potential for new entrants offering bundled data gathering services for car maintenance—such as Drivelog, developed (but since sold) by Bosch (see Kempf et al., 2018, p. 25)—it is difficult to imagine that the manufacturers can be easily cut out of their privileged position in these business models.

Finally, the changing nature of products has multiple implications for aftermarket business models. The advent of autonomous driving systems, advanced electronics, and electric and hybrid propulsion highlight the increased role of diagnostic capabilities, digital competencies, and technological adaptation. The improved quality of parts means less overall maintenance and parts replacement, even if autonomous driving systems require more frequent adjustments. When parts do need to be replaced, their increasing value-added means that more of the profits will go to parts manufacturers and distributors. As such, for a segment of the industry predicated on lower pricing, the need to upgrade skills but keep prices low will be a significant challenge moving forward.

The aftermarket is engaged in the exploration of new strategies and business models. New technologies require greater investment in machinery and technological competencies, but independent repair shops have limited financial capabilities. They are thus increasingly affiliated with banners to secure more advantageous access to parts, facilitate technological access, and draw on the banners' marketing prowess to

secure brand awareness, loyalty, and better customer experience. The consolidation of banners and parts distributors accentuates this process, as significant restructuring among a number of international players—sometimes backed by aggressive investment funds—drives increased merger and acquisition activity in the industry.

Parts distribution

With their niche role between parts manufacturers and the aftermarket, many of the same disruptive factors affecting traditional business models are also opening up new opportunities for parts distributors. First, similar to dealers, new models of direct distribution (e.g., the do-it-yourself parts market) constitute a significant threat to this segment of the industry. Direct distribution can take the form of parts sold directly to consumers by manufacturers, as well as the emergence of alternative intermediaries (e.g., Amazon) that take business from traditional distributional channels. Indeed, many observers believe that the major change coming to parts distribution is the entry of technological platforms with enhanced capacities and digital distributional expertise. Second, a key question cutting across the auto services industry will be: who controls customer data in terms of ownership, access, and marketing ability? Will it be OEMs and other manufacturers, dealers, parts distributors, the aftermarket, insurers, or new entrants with stronger technological capabilities?

If these firms can draw on economies of scale, further consolidation of ownership, and strong technological capacity, they can develop new business opportunities such as increasing recourse to big data and advanced analytics. This will allow distributors to store vehicle information and exploit customer information as a source of value, enabling direct marketing to consumers with more differentiated service offerings, as well as more packages of services for workshops using their products (Kempf et al., 2018). Moreover, technologies are evolving so quickly—and the competition to provide parts is so intense—that parts distributors are now playing an increasing role in the training of their customers on efficient installation of the parts they are selling. For parts distributors, there are increasing skills gaps between the relatively low-wage and low-skill profile of the bulk of the workforce physically manipulating parts in warehouses, and the sophisticated workforce required to ensure the data analytics for these logistical and distribution systems. Part of this workforce is likely to experience significant technological disruptions through robotization and new delivery systems—strategies already underway among the most advanced parts distributors.

Body repair shops

Body shops also face significant technological disruption. First, they require access to the codes and diagnostic tools characteristic of new generations of vehicles. As they typically repair all brands of vehicles (often, recent models involved in accidents), the issue of technological access and its cost looms large, since manufacturers can determine the extent and cost for third-party access to perform such repairs. Second, with this expanding technological

footprint, there is a need to upgrade facilities and expertise, leading to significant consolidation in the industry and altogether less scope for small independent workshops (e.g., the entry of ADAS systems that require both larger workshops and technological access to calibrate). Alternatively, body shops can subcontract this work to dealers, but this would dip into their profit margins. Third, as parts have increasingly high value-added and embedded technologies, they need to be replaced rather than repaired; as such, manufacturers and parts distributors can increase profits at the expense of body shops. Fourth, there is an emerging skills gap between the traditional image of vehicle repair (e.g., "fender benders") and the present-day reality of the sophisticated diagnostics used to repair new vehicles. Finally, the insurance sector's increasing use of AI is transforming the work of estimators and repairers, as digital photographs and evaluation algorithms displace tasks normally performed by body repairers. Moreover, these same technologies allow insurers to squeeze the margins of body repair, setting prices and standards for repair work with limited scope for negotiation.

Body shops are developing several strategies to respond to these pressures, including increased affiliation with banners to facilitate access to parts, technologies, and training; corporate consolidation and restructuring, as larger companies become increasingly important; increased size and sophistication of repair shops; greater training to master technological requirements; and greater emphasis on the customer experience.

To recap, multiple disruptions are shaking up business models across the auto industry, further intensifying competitive pressures and disrupting traditional power relationships in the value chain. As argued in the first section of this report, these shifts in business models depend on the availability of critical capabilities and skills. Businesses need skilled labour to pursue strategies designed to take advantage of the fast-paced opportunities offered by this new competitive landscape. The next two sections will examine the implications for skills and the training ecosystem.

Skills and Training Challenges

The previous section explored how significant technological disruptions and other trends have affected existing business models, as well as the nature and intensity of competition between different segments of the auto services industry. Many of these disruptions highlight the importance of skills and competencies in the strategies developed to deal with transformative change. A key tension to be resolved is between the competitive positioning of business models and the skills and knowledge required to exploit those models. This in turn raises questions about the capacity of stakeholders' existing skill sets and competencies to pursue the strategies they are developing. In other words, success depends on a dynamic alignment between the business model and the knowledge, capabilities, and skills required to enact it (Storey & Salaman, 2008).

Our particular focus is on ongoing skills and training challenges in Québec. As was argued in the first section of this report, skills are not produced in a vacuum—rather, they are developed in very specific ecosystems as a result of institutions, actor strategies, and common understandings produced over time and intentionally translated into skills settlements (Buchanan et al., 2017). Technology can be a disruptive factor for these skills settlements, which sometimes integrate these disruptions, other times innovate to adapt to them and in yet other instances find it difficult to deal with them. These challenges in auto services also illustrate the kinds of problems faced by other global industries and specific regions dealing with technological disruptions.

This section focuses on analyzing the skills required for different segments of the industry. First, "skills shortages" concern the significant challenges in retaining and replacing the existing workforce. Second, "skills gaps" refer to the gaps between the skills available and skills required to repair the new generations of motor vehicles, affecting both the current workforce and new entrants into the industry. Third, there are a series of future skills issues arising from technological disruptions. Overall, there is a major concern with regard to the ability of basic and advanced training to keep up with the technological transformations underway—thus threatening the success of strategies being developed for adapting business models to this new industry landscape. As we shall explore in a later section (see page 53), this has led to a range of innovations that seek to address the current skills challenges.

One of the main points emerging from our interviews with industry stakeholders is their ***difficulty in recruiting qualified mechanics and apprentices.***

Skills shortages

A major problem for the auto services industry in Québec concerns skills shortages. One of the main points emerging from our interviews with industry stakeholders is their difficulty in recruiting qualified mechanics and apprentices. These shortages are reported right across the industry and affect all segments. In the words of one industry observer, "There is a labour crisis... whether it is the aftermarket, the auto manufacturer, the repair technician, body shop repair… it does not matter. There is a labour shortage."

These shortages have become increasingly problematic. In the 1980s, our interviewees recall that there was a supply of candidates to fill vacancies; Québec is characterized by two pathways to become an apprentice, and neither appeared to experience particular difficulties. School-based vocational programs for future auto mechanics continued to fill their classrooms. New apprentices could also be recruited directly, without prior vocational training, to undertake workplace-based apprenticeships. The typical recruit was a young man in his late teens who was passionate about motor vehicles. Those without prior vocational training had often not completed high school. With the technology still in the first phase of change (see Table 3), most skills for vehicle maintenance and repair could be learned on the job or through the basic training.

The skills shortage began taking root in the late 1990s, according to our industry participants, and has since remained a major issue. In 2013, according to a survey conducted by the sectoral committee in the industry, 34% of employers indicated that it was difficult to fill the positions they were posting (Senneville, 2013). In 2018, 80% of members of the industry association for automobile dealers, which represents one of the main sub-sectors in the auto service industry, reported labour shortages (Corporation des concessionnaires d'automobiles du Québec [CCAQ], 2019). Given that the salaries and benefits in this segment were among the highest in the industry, the shortages in the aftermarket were even more severe. As one employer recently recounted, "We'll hire just about anyone."

There are several dimensions to this skills shortage. Initial entry into the sector does not appear to be sufficiently attractive, whether through the training path or direct entry into the labour market. For those entering through vocational training courses, it is increasingly difficult to fill and maintain the training cohorts: these courses are often poorly integrated with both workplaces

and new technologies, with students also being asked to study without earning any income. The rate of attrition is high. For those opting for workplace apprenticeships without doing vocational training, there are other deterrents: wages are low, working conditions are poor, and the quality of mentorship is often sub-optimal, leading to high rates of attrition. Moreover, the first years of the apprenticeship are often characterized by an array of low-skilled tasks such as changing tires, lubrication, prepping vehicles, and so on. Some of this work is also seasonal, potentially leading to layoffs when there is a lack of work.

These shortages are also exacerbated by other factors. Wages and working conditions in other sectors are generally better than those offered to auto technicians. Market prospects for graduates of vocational training are frequently more attractive in other industries hiring vehicle technicians, such as construction, mining, oil and gas extraction, and public transportation agencies. For the heavy vehicle sub-sector, many vocational graduates and qualified technicians prefer to pursue their careers in more lucrative industries than in speciality vehicle shops. For instance, for unskilled apprentices who have not taken the vocational course pathway, wages can be more attractive in the general service sector. In other words, the benefits of investing in a workplace apprenticeship are not evident, relative to the salaries available over the short-term in industries competing for comparable unskilled labour (e.g., fast food). Thus the auto services industry is decreasing in attractiveness for younger entrants into the labour force. This can be attributed to the physicality of the work—the industry's "grease monkey" image—as well as the financial burden for new entrants, who are expected to purchase their own tools (often $5,000 or more for those already earning low wages).

Additionally, the intense competition between different segments of the industry means that keeping costs low is paramount for some business models. Unfortunately, with more of a focus on short-term profitability, some employers are reluctant to hire or pay for more qualified candidates when they can pay less for unqualified candidates. A more attractive destination for young workers in Québec is the regulated construction industry, where vocational training is compulsory for most trades, ensuring that wages cannot be readily undercut. The workforce is largely unionized, offering many benefits such as industry-wide pension schemes and attractive wages and benefits for new entrants. Moreover, training is well-reputed and organized for the industry as a whole, and financed both by employers and employees.

The demographic challenge of an aging workforce accentuates labour shortages, as skills being lost with retirements are not readily replaced. As one employer observed, "I think the average age is now 57 in our mechanics market and there is virtually no succession." This is a problem that cuts across jurisdictions in Canada where—drawing on the most recent census data—just under 20% of automotive service technicians in 2016 were 55 years or older (see Table 4). In Québec, this demographic challenge is more acute in body repair, where

28.5% of body repairers corresponded to this age profile. These demographic pressures in auto services are all the more acute because of entry-level problems in filling cohorts, through vocational training courses or finding new apprentices.

Many industries are able to mobilize alternative sources of labour supply. The two most common strategies are through the entry of immigrants and women; however, the auto services industry as a whole is a chronic underperformer on gender equality, and the Québec industry is much weaker in the mobilization of immigrants. According to the most recent 2016 census data (see Table 4), 2.1% of auto service technicians in Canada were women, with 2.2% in Ontario and just 1.6% in Québec. This is extremely low when contrasted with the overall labour force, where roughly 48% of workers were women. "Immigrant workers" refer to those who have come from outside of Canada, irrespective of whether they have obtained Canadian citizenship, are landed immigrants, or are permanent residents, and represented 23.1% of the overall labour force in 2016. In the Canadian auto service industry, 18.4% of auto service technicians were immigrants, with 26.2% in Ontario (as opposed to 30.6% of the overall labour force) and only 9.5% in Québec (as opposed to 15.5% of the labour force). As we shall explore in subsequent sections, some employers are seeking to innovate in sources of recruitment—notably through sponsored immigration programs—but the industry is underperforming in the attraction of immigrant workers, and it has not been successful in filling labour supply gaps. Indeed, many industry observers report that the labour shortages can be so acute in some regions that businesses are increasingly unable to meet demand for their services or, indeed, to ensure their survival.

Labour shortages will, of course, vary by sub-sector and region. Some trades are more difficult to recruit, notably mechanics (52%) and body technicians (23%) among car dealerships (CCAQ, 2019). However, dealerships—especially those that are unionized—often benefit from higher margins and a more sophisticated range of incentives for worker retention (e.g., pension plans, benefits, better working hours, and training opportunities), and therefore experience less turnover and more labour force stability. These dealerships are perhaps less affected than businesses in the aftermarket whose business models depend on cost competition. The challenge of scarcity for workers with lower skill is recurrent, according to one interviewee, "especially the salaried employees, with low wages, fewer skills, and less training. That's the lack of manpower... not at the level of jobs with good pay, with good skills." Chronic shortages of labour in the body shop sub-sector illustrates this problem, exacerbated by the tight control of costs and pricing maintained by the insurance companies that typically underwrite the cost of repairs on vehicles that have been involved in accidents.

Regional labour markets also influence the scarcity of workers. Labour shortages represent a province-wide problem but, according to many interviewees, are more intense in remote regions due to rapidly aging populations and locally specific labour market dynamics. Regions with low levels of unemployment, such as Québec City, experience more acute labour shortages in

TABLE 4

Female, immigrant, and older workers among automotive service technicians and body repairers (2016)

Geography	Category	Total and percentage of workers by category	Automotive service technicians, truck and bus mechanics, and mechanical repairers (7321)	Motor vehicle body repairers (7322)
Canada	**Number of workers**	**18,499,405**	**154,720**	**29,175**
	Female (%)	48.3%	2.1%	4.2%
	Immigrant (%)	23.1%	18.4%	21.4%
	≥55 years old (%)	22.6%	19.8%	25.8%
Québec	**Number of workers**	**4,244,290**	**37,200**	**7,205**
	Female (%)	48.2%	1.6%	3.2%
	Immigrant (%)	14.5%	9.5%	8.9%
	≥55 years old (%)	22.0%	19.5%	28.5%
Ontario	**Number of workers**	**7,006,945**	**55,440**	**9,285**
	Female (%)	48.8%	2.2%	4.5%
	Immigrant (%)	30.6%	26.2%	32.0%
	≥55 years old (%)	22.4%	19.9%	27.8%

Source: Authors' calculations based on the 2016 Census of Population (Statistics Canada, 2018b).

the auto services industry than in outlying regions with higher levels of unemployment. In regions characterized by dynamic industries with high wages—such as mining in Abitibi-Témiscamingue—auto services are less attractive for young workers, who can secure better salaries in other sectors with a relatively low investment in education or training. In contrast, auto services jobs require a significant investment in vocational training, apprenticeships, and the purchase of tools as start-up costs.

The challenge of skills gaps

Another challenge, which is a direct consequence of technological transformations, is presented by the growing *skills gaps*—referring to the gaps between the skills possessed by the bulk of the workforce and the skills required to maintain and repair the new generations of vehicles.

As argued in the previous section, vehicles are undergoing rapid transformations with regard to the new technologies embedded in them. This contributes to skills gaps, which are widely recognized by industry observers. These new technologies (e.g., on-board systems, computerization, new modes of propulsion, and the growing sophistication of parts and components) all affect the types of basic skills required. Maintenance and

repair tasks are thus migrating from pure mechanics to incorporate electronic and digital diagnostics. These growing skills gaps are highlighted by one industry observer:

> *Today, there are 2,000 to 3,000 sensors in a vehicle. Imagine that the sensors are affected by a problem of moisture, condensation, cutting a wire, and a ground that has rotted—and the ground doesn't work anymore… Just to start looking at the problem, if the individual doesn't master the multimeter, he's not even able to work on a problem like that... [and] he has to understand how to read a map. He has to understand how to read an electrical map, how to read the on-board computer.*

The advent of hybrid and electric vehicles and developments in autonomous driving represent further paradigm shifts in terms of the gaps between workers' knowledge and the skills required to repair cars. Most auto service technicians have learned their trade mechanically; basic electronics are often not mastered by these technicians. "Critical thinking" is also deficient. In particular, this entails the capacity to understand problems in vehicles and to find solutions in a systematic way, such as by locating problems in the digital networks integrated into vehicles. Another feature of the skills gaps associated with electric vehicles is health and safety. For instance, the Association des Véhicules Électriques du Québec (AVEQ, 2019) reports that the most powerful electrical engines can have an electrical tension up to 100 kWh, compared to a standard hybrid that ranges between 1 and 3 kWh. Such high-tension motors completely change the paradigm for safe work, requiring changes in both the physical layout of workshops and workplace safety protocols.

In a mechanically-centred world, the rudimentary skills of workers without basic vocational training was less of a problem, since automotive systems were relatively simple and on-the-job learning was adequate to practice the trade. However, the gap between the general skill level of workers and the level now required appears to be widening at a rapid pace. As recounted by one observer, "The problem is that there's [so] much electronics in the vehicle. For pretty much every part that you have to touch, it takes a scanner to reset it, install it, and find out if it's defective." In other words, the very nature of these "computers on wheels" continuously enlarges skills gaps. New modes of propulsion, computerization, and changes in parts and components make the work less physical, but also highlight the need for intellectual skills and a deep understanding of the new systems.

These skills gaps highlight six types of problems. First, computerization accelerates the need for new skills, but also the importance of basic skills. It is difficult to acquire the necessary technical skills in the absence of basic literacy and numeracy skills, which were often not mastered at school by auto service workers. The absence of basic or essential skills becomes an impediment to further learning, as workers are effectively left behind. The auto services industry in Québec is a destination of choice for many early leavers from school. These new entrants are typically young men who find working with vehicles attractive and

often are not motivated to continue formal schooling. They therefore enter the industry without initial vocational training and embark on apprenticeships to learn on the job. Indeed, they accomplish many of the same tasks as the more qualified apprentices who have completed their vocational training, for a comparable hourly rate. However, they do not have the initial training necessary to deal with more complex technologies and vehicle diagnostics. In other words, there is not only a problem of new skills to be acquired, but also impediments in equipping the existing and future workforce with these new skills, partially due to shortcomings in workers' capacity for continuous learning.

Second, those who have acquired vocational training often do not have the requisite skills for practical industry applications. Some observers emphasize that vocational curricula cannot keep pace, arguing that vocational schools do not even have models of the new vehicles on which to develop their skills. Schools also lack access to the proprietary technologies to perform relevant diagnostics, preventing learning opportunities with the more advanced electronics required for an understanding of the new generations of vehicles.

Third, in garages and workshops, there is an increasing differentiation between those who can and cannot work effectively on the new generations of vehicles. In other words, irrespective of initial training and professional trajectories, some technicians prove to be adept in the use of the new technologies (e.g., complex diagnostics), whereas others are not well-equipped to make this transition. Increasingly, there is an informal division of labour—along a continuum—between these different levels of skills. Businesses can ill-afford to lose their top diagnosticians to their competitors, and as such, these highly skilled technicians

benefit greatly from their market power. Problems associated with retention and poaching are even more acute in the aftermarket, which is generally composed of smaller enterprises that often employ fewer than ten employees.

Fourth, skills gaps are further exacerbated by the training system and its method of certifying qualifications. The skills regime for auto services in Canada is a patchwork, where trade certification is compulsory in some provinces and territories (Nova Scotia, PEI, New Brunswick, Ontario, and Alberta), yet voluntary in others (Newfoundland and Labrador, Québec, Manitoba, Saskatchewan, British Columbia, Yukon, Northwest Territories, and Nunavut). While occupational standards tend to be similar—notably, through Red Seal certification and provincial coordination in Québec—there is a variable geometry in terms of the overall structuring of the regime. For those provinces, like Québec, where certification is voluntary, it means that skills are not necessarily certified for a significant proportion of the workforce. Of course, there is a certification process for auto service technicians in Québec; however, certification is not compulsory to work in the industry. It is generally estimated that less than half of technicians have such certifications, and a significant proportion of "apprentices" continue to work beyond the normal period of apprenticeship, becoming life-long apprentices rather than moving toward the certified "journeyperson" status.

There are typically two avenues to acquire a qualification as a certified technician in Québec (see Figure 6 on page 48). One avenue is to enroll in a vocational program at secondary school or college, then complete an apprenticeship, and finally succeed in qualification exams— ultimately achieving recognition as a journeyperson. The second avenue entails an apprenticeship with mandatory coursework, which leads to the qualification exams. By not requiring qualification, which also keeps wages lower, some auto companies intentionally create a competitive advantage whereby they can undercut the prices charged by other businesses who employ more expensive, fully qualified technicians. Indeed, the industry is predicated on this difference, which is why consumers will favour the cost advantage of the aftermarket when their warranty has expired. Moreover, as we shall explore in the next section, the rate of failure in the qualification exams is in fact very high, both for those who completed the initial vocational training, as well as for those who entered the industry through workplace apprenticeships. This highlights broader issues with training regimens and overall skill levels in the auto services industry, for both initial vocational training and on-the-job training.

Fifth, even for those who are qualified, there is no obligation for continuing education or training. Motor vehicles are rapidly being transformed; however, licensed journeyperson qualifications are increasingly outdated, with a focus on more traditional, mechanical skills. Whereas some technical professions require continuous updates through training to maintain their standing in the profession, no such requirement exists for qualified auto service technicians. This is not to suggest that licensed technicians are not interested in such training;

***New technologies are disrupting the boundaries between trades**: where some see new possibilities, others see a slippery slope to deskilling.*

workers in dealerships are likely to receive regular training on new products from manufacturers. Yet this obligation is not consistent and is often related to specific products, as opposed to the acquisition of key general skills for working on new technologies in the industry.

Finally, these technological transformations raise the question of the extent to which skills should or should not be fragmented. Historically, there is a limited number of recognized trades in auto services. For example, the skills required to engage in auto body and collision repair are not the same as the skills necessary to service an engine. Heavy vehicle motors also require different skill sets from regular vehicle motors, while vehicle painters (known as "refinishing technicians") have completely distinct skills. However, the generic core trade in the industry is generally labelled "automotive service technician," which is a term that covers a wide range of functions including preventative maintenance, diagnostics, and repair of systems in cars and light trucks.[5]

Yet the available technologies and tools have opened up new possibilities for even narrower skill sets. The impact of this trend has generated much debate between different industry stakeholders. For example, it is now possible to become a "diagnostic technician" who has neither vocational training nor licensed qualifications, but who is proficient with a tablet that can connect with the computer systems of a vehicle and perform a preliminary diagnostic—in essence, completing a pre-scan and post-scan for maintenance. Some stakeholders see this option as an attractive solution to both labour shortages and cost pressures, whereas others see it as a slippery slope, on which safety and overall understanding of vehicle systems will be sacrificed for an expediency likely to undermine consumer safety. Unions have traditionally defended unified trades that diagnose and perform all the work in their specific segment of the industry (e.g., cars and light trucks, heavy vehicles, and body repair). Within these trades, the only gradation of skill pertains to the "class" of the journeyperson, where classes A and B are higher than C, which is the entry level. Some argue that new technologies will force greater specialization

5 Red Seal vocational standards permit mobility of workers between provinces within Canada. According to Red Seal classifications, the areas of expertise for an auto service technician include engines, vehicle management, hybrid vehicles, steering, braking, drive trains, suspension, electrical, as well as heating, ventilation, and air conditioning (HVAC) systems. Auto service technicians also work on vehicle restraints, trim, and accessories (Red Seal-Sceau rouge, 2021).

while also eroding the industry's governance and oversight of trades, as stated in a comparison to the construction industry:

> *[The auto services industry is] going to have to diversify... in construction, [they] have electricians, plumbers, and carpenters, yet a house is not as complicated as a car. [They have different specialists] who do the foundation, the roofing, and the painting. For us in automobiles, the same person has to do the mechanics, the electricity, the electronics, the hydraulics, and the computers—[which] is absolutely impossible these days.*

Alternatively, it has become possible to envisage the emergence of a new type of technician, whose skill set is more typically associated with college-level as opposed to basic vocational training.[6] This could eventually lead to two tiers of service technicians: 1) a general mechanic, as is traditional, and 2) a "super" technician, whose tasks would be more complicated and technologically-driven. Such an informal division of labour is already present in certain larger workshops, to some degree.

Future skills

A third set of skills issues is related to technological transformations and their impact on future skills. A first issue is the impact of these skills gaps on early leavers from school. One of the challenges of digitalization concerns the gap between lower and higher skills in the labour market. As argued in the OECD (2019) report on technological challenges, low-skilled workers face a huge challenge because their skills gap is among the largest, yet they are also less likely than other workers to participate in on-the-job training. These workers often require training in areas which were lacking in their earlier education: a good level of literacy, numeracy, and problem-solving skills for technology-rich environments. Without this foundation, they cannot adapt to new technologies "in diversified and complex ways rather than just for information and communication" (OECD, 2019, p. 11). This is a particular challenge in auto services, where many industry observers have highlighted that their workers struggle to acquire new technological skills. The skills gap has reached a threshold for which, it can be argued, there is scope for public policy concern about the impact of technological change on these workers' livelihoods.

A second issue concerns public safety and the regulation of skills, which are likely to be of great concern over the coming decade. In the case of autonomous vehicles, repair work has become associated with issues of safety for the public—especially when poor calibration can undermine the effectiveness of systems. The increasing use of automated and driverless technologies, such as ADAS,

6 In the Québec system, high school-level vocational training leads to a DEP (*Diplôme d'études professionnelles,* or diploma of vocational studies [DVS] in English), whereas training in a specialized course at the college level (CEGEP) would instead lead to a DEC (*Diplôme d'études collégiales techniques*) or an AEC (*Attestation d'études collégiales*).

will rely on auto technicians. Do these technicians have the competencies to ensure that vehicles are safe? Who is responsible for an accident in cases of poor calibration in these kinds of vehicles? As is the case of many regulated professions ensuring public safety, will strong industry-wide standards emerge, independent of particular vocational systems? It is possible that in cases of tragic mishaps attributable to vehicle maintenance, regulatory requirements will quickly be enacted, regardless of industry reticence. A well-trained workforce with up-to-date knowledge and skills will be essential in this new automated context, and pressures for public regulation are likely to increase as these technologies become more widespread.

A third issue arises from the industry "training trap" for SMEs, who are least likely to underwrite the costs of training due to their relative size, as well as poaching and retention issues. As such, these small firms would likely derive the most benefit from collective solutions to skills gaps (Bélanger & Hart, 2012). One solution is to ensure that all workers in the industry must have basic qualifications, which would help reduce the impact of this training trap. Such strategies are standard for many professional standards and certifications, e.g., doctors, electricians, nurses, accountants, and lawyers. Of course, the public does not want to have unqualified electricians undertaking electrical wiring, with the consequent risks of fire and other dysfunctions. Such logic could also be more rigorously applied to auto services, especially given the immense risks that driving entails. Vocational certificates, apprenticeships, and qualification exams are part of an elaborate system to ensure that standards are established and fulfilled by workers in a particular trade. For SMEs, this type of system can either support or hinder a stable employment architecture, depending on whether it is organized effectively and implemented collectively. As we will see in the next section, this is one advantage of the decree system in the Québec auto services industry, whereby in certain regions the terms and conditions of the unionized workers in this industry are, in principle at least, extended by government decree to all workplaces in the industry, be they unionized or not. Such industry standards for wages and working conditions are also an important dimension for training in the regulated construction sector in Québec.

A fourth important issue concerns the emergence of green skills. Given the urgency of the climate crisis and the need to reduce CO_2 emissions, a significant transformation of vehicles is coming from two sources. First, the major auto manufacturers are investing heavily in innovations to reduce carbon emissions, notably through the development of hybrid and electric propulsion systems, but also through telematics and vehicle connectedness for more autonomous vehicles. Second, public policy is putting pressure on manufacturers to accelerate these developments, while also influencing consumers through subsidies for the purchase of such vehicles. The challenge is that the downstream segments of the industry—the maintenance and repair of vehicles—are not properly tooled for this transformation. There is a real "green skills gap." New technical skills are required, but, as in other segments of the industry,

auto service technicians often either lack the basic or essential skills for this green upgrade or they do not have access to the kinds of training required to fill this gap.

To summarize, given the growing gaps between technologies and skills, the auto services industry is facing multiple strategic challenges in its workforce—including shortages and the difficult demands of emerging future skills. These challenges cannot be understood without reference to the fierce competition that characterizes the interdependent segments of this industry, changing business models, and the problems of unequal access to vital technologies for the maintenance and repair of vehicles. All segments of the industry face shortages of skilled and quality labour and struggle to attract the quality of labour they require (skills gaps). Disparate wages between different segments lead to poaching and retention issues for companies, as well as creating downward pressures on the price of repairs from manufacturers. These factors affect the industry's ability to keep pace with technological requirements and the trade's overall attractiveness to young workers. In the aftermarket, incentives and capacity to train workers are low, and wages usually remain well below the standards observed in dealerships. Still, dealers are also hit by these skills gaps, and many companies cannot afford to invest the human resources costs of attracting, retaining and motivating this workforce nor the training costs required to bridge the skills gaps that characterize the industry. Finally, it is also hardly surprising that, in an industry characterized by chronic labour shortages, there are multiple obstacles to establishing compulsory certification, which could create foundational standards for auto service technicians while enabling them to achieve the relevant requirements of future jobs.

There are no one-size-fits-all solutions to these problems. In the short-term, scarcity and shortages require strategies to retain and attract skilled workers to the industry. Over the longer-term, the skills gaps and the emergence of future skills will require sustained investment in training and a collective skills ecosystem among stakeholders. We will see in a later section (see page 53) that—in the face of considerable uncertainty—industry actors are engaging in both short- and long-term experiments to meet these challenges. The Québec experience, along with the ingenuity of the actors seeking to resolve these problems, offer much that we can learn from, both positive and negative. Their efforts will shape how we consider the evolution of skills and training in the Canadian auto services industry.

The Ecosystem for Training and Social Dialogue in Québec

Vocational training in Canada

Canada is known for its strong tertiary education programs, but also its weak vocational training system, which has been aptly described as the "poor second cousin in a well-educated family" (Charest & Critoph, 2010), with apprenticeships frequently placed at the bottom of the education hierarchy. Industry observers typically decry the low status of vocational training in auto services. As recounted by one industry specialist:

> *Parents do not want to see their children in these programs… [they] are made for students in secondary school who do not know what else to do, or whose academic results are too weak to envisage any other pathway in the labour market… Kids enter these programs when they do not know what else to do!*

The low status of vocational training in the industry contrasts markedly with the rapid technological transformations affecting motor vehicles, and this contributes to a growing skills gap between vocational training programs and the skills required to maintain and repair motor vehicles. This observation was repeatedly confirmed by many stakeholders who participated in this study. The Canadian system of vocational training is a complex patchwork, with its cornerstone being apprenticeships, which comprise a triangular relationship between an apprentice, their employer, and a body responsible for training and certifying qualifications. The apprentice normally receives a proportion of the wage of a certified journeyperson, on-the-job training and mentorship, and, depending on the provincial system and industry, enrolment in a vocational program (Charest & Critoph, 2010).

Since labour market training is a provincial responsibility, there are multiple systems and vocational training requirements across Canada. Vocational qualifications might be mandatory in one trade but not others; similarly, training requirements might be mandatory in one province, but not another. Where it is not mandatory, this means that individuals without a trade certificate or diploma are permitted to work in the same occupation alongside a fully qualified journeyperson (Charest & Critoph, 2010). For auto service technicians specifically, vocational certificates are compulsory in some provinces (e.g., Ontario and Alberta)

and not in others (e.g., Québec and British Columbia). Occupational requirements will thus also vary from one jurisdiction to another (Laporte & Mueller, 2011). In Québec, as we shall see below, they can even vary by region. The oversight of these apprenticeships is generally the responsibility of industry- or trade-specific bodies that are established and regulated in each province. This explains, for example, how Québec has developed its own set of very specific institutions for the training and recognition of qualified auto service technicians. Such institutional specificity in the Canadian auto services industry demonstrates the importance of looking at particular ecosystems in different regions.

The Red Seal program seeks greater coordination of particular trades and their skill requirements across provinces. Ostensibly designed to facilitate interprovincial mobility in trades, it increasingly provides a benchmark for occupational standards and the composition of required skills (known as the "Ellis Chart").[7] Québec's jurisdiction over its labour market development and training distinguishes it from the rest of Canada, further contributing to the specificity of its skills ecosystems. Indeed, many studies of apprenticeships in Canada simply exclude Québec, or report that the data is unavailable or unreliable because of the distinct nature

*A Statistics Canada study of the period between 1995 and 2007 found that the **completion rate for all apprenticeships** in Canada—from registration to successful completion—was only **10.5% in 1995** and further declined to **6.8% in 2007***

of its training system. We believe that this is an important oversight, due to unique features that can provide different lessons for the industry, particularly its ability to engage multiple stakeholders in continuing dialogue and bottom-up innovation.

Another challenge is evident from the very low completion rates for apprenticeships. A Statistics Canada study of the period between 1995 and 2007 found that the completion rate for all apprenticeships in Canada—from registration to successful completion—was only 10.5% in 1995 and further declined to 6.8% in 2007. The rate for auto service and heavy vehicle technicians was comparable, declining from 10.9% in 1995 to 7.6% in 2007 (Laporte & Mueller, 2011, p. 10).

7 The Ellis Chart website provides comparative data on designated trades in Canada, including all Red Seal trades. Named after one of the pioneers in the development of apprenticeships in Canada, it is produced by Employment and Social Development Canada (ESDC) in partnership with the Canadian Council of Directors of Apprenticeship (CCDA).

In order to better illustrate the innovations occurring in training for auto services, we first focus on the institutional mechanisms for social dialogue and the present-day provision of training in Québec, offering a portrait of its skills ecosystem for auto service technicians. We then explore the variety of professional trajectories for this occupation, providing the context for several training innovations currently underway.

The Québec ecosystem for the training of auto service technicians

Institutional structure

Drawing on the history of labour relations in auto services and the broader labour force development strategy from the 1990s, the Québec skills ecosystem for the training of auto service technicians is unique within Canada. It is made up of multiple institutions and associations, which intersect, compete, and collaborate while also empowering different stakeholders to engage in training innovations.

The primary feature is the "collective decrees system." Drawing on European traditions legislated in the 1930s (Bernier, 1993), Québec is unique in its collective decrees system, whereby unions and employers in certain industries and regions negotiate employment in a collective agreement, some features of which are then extended to all designated workers in that industry and that particular region. Once an agreement on the content of the potential decree is established, a request is then made to the Ministry of Labour to extend its terms and conditions (by formal government decree) to all of those working in specified occupations in that industry and region.[8]

In the auto services industry, unionized workers (primarily in dealerships) negotiate their regional collective agreement with an employers' association. After review by the Ministry of Labour, the agreement is extended to all other workers in relevant occupations within a particular region. Although the minimum terms and conditions negotiated are also applicable to the aftermarket, observers agree that the wages and working conditions specified in the governmental decrees are generally much lower than what employers actually pay the workers covered by these decrees—and all the more so in the context of the upward pressure on wages due to chronic labour shortages. The decrees system is further complicated by the patchwork nature of its coverage: six regions are currently covered by decrees, representing approximately 80% to 85% of workers in the industry. Although decrees do not reflect real wage practices (working conditions in dealerships are superior to the aftermarket), they nonetheless provide an important institutional mechanism for a range of functions pertaining to qualifications and the regulation of trades and training.

8 Although common in a number of continental European jurisdictions, the extension of collective bargaining agreements is unique to Québec within North America. The current regime is the direct legacy of a 1934 law (*Loi sur les décrets de convention collective*). Just a few sectors—including security guards, contract cleaning, and auto services—are still regulated by such decrees. For auto services, the regime is applicable in six regions, covering approximatively 80% to 85% of auto workers in Québec.

A second feature of the auto services skills ecosystem in Québec is the bipartite industry body in each region that governs decrees and many other aspects of skills and training. Negotiations for collective agreements take place through the auspices of a parity committee (*comité paritaire de l'automobile* [CPA]), in which both employers and unionized workers are equally represented with an independent secretary and staff. Apart from its role in presenting the outline of decrees to the Ministry of Labour, a regional parity committee also fulfills other functions. CPAs collect a levy—a small percentage of hourly wages (e.g., 0.035%) from both employees and employers to ensure their continuing role in the industry. This role includes an overview of the apprenticeship system in the industry, ensuring that regional provisions for ratios of journeypersons to apprentices are respected. CPAs administer certification exams for workers to obtain qualification as auto service technicians, ranging from an entry-level "C" card to a higher level of competency with an "A" or "B" card. They also inspect garages and workshops to ensure that the minimum terms and conditions set out in the decree are being observed. Finally, CPAs provide preparatory training for the qualification exams and continuing education for those already qualified.

This range of functions has been expanding under the auspices of a provincial council of CPAs (the Conseil provincial des comité paritaires de l'industrie des services automobiles [CPCPA]). In contrast to many other jurisdictions in Canada, the CPCPA ensures ongoing union–employer dialogue about the regulation of the industry,

A second feature of the auto services skills ecosystem in Québec is the ***bipartite industry body*** *in each region that governs decrees and many other aspects of skills and training.*

including how to address skills challenges. However, a particular challenge stems from the patchwork nature of the system—since most, but not all, regions are covered by such committees, conditions depend on a sufficient degree of unionization to negotiate appropriate sectoral agreements in each particular region. In the absence of a regional decree, workers and employers in certain regions can fall outside of the parameters of the dominant training and qualification system, thus creating regulatory loopholes, even in adjacent and nearby cities located just a few kilometres away.

Another unique feature of the Québec skills ecosystem stems from the evolution of the province's multi-tiered labour force development strategy. The initial step was the 1995 introduction of a province-wide training levy, whereby firms with a wage bill over a certain threshold were to pay a 1% levy if they could not demonstrate that they

had spent this percentage on the training of their workforce.[9] Though some argue that this step has increased reliance on external training consultants, most employers have integrated this regulatory requirement into their training expenditure in order to meet this minimum threshold (Gagnon & Smith, 2013). The second step saw the creation of a Labour Market Partnership Board (Commission des partenaires du marché du travail [CPMT]) in 1998. This bipartite body—which affirmed Québec's jurisdiction over labour market issues, in keeping with the Canada–Québec Labour Market Agreement (Canadian Apprenticeship Forum [CAF], 2004)—brought the major social partners into dialogue over training strategies. The third step in this process, and of great importance for auto services, was the creation of workforce sectoral committees through the late 1990s. These bi- or multi-partite committees (*comités sectoriels de main-d'oeuvre* [CSMOs]) are concerned with skills and training in different industries, undertaking a wide range of activities: from diagnostics of training needs in their sector to developing training plans to address labour shortages of particular occupations. The CSMOs are funded by the CPMT and rely on its funding for project-specific initiatives. In contrast to the sectoral committees developed at federal level, Tremblay et al. (2005) argue that their decentralization, proximity to local needs, and traditions of concertation and social dialogue have contributed to greater success. Moreover, after more than two decades, these CSMOs remain an integral part of the training ecosystem for particular sectors or industries, providing an example of stakeholder involvement in skills training that is quite unique within Canada.

A good example is CSMO-Auto, with which our study has collaborated extensively due to its focus on training needs in the auto services industry (CSMO-Auto, 2021a). The governing body of CSMO-Auto is multi-partite, including 13 representatives from firms, eight from unions, one from the CPAs, one from the consumers' association, the Canadian Automobile Association (CAA), two from ministries (Labour and Education), and one from its overview body, the CPMT, which in turn is financed by the Ministry of Employment (Emploi Québec). CSMO-Auto diagnoses the main labour force issues in its sector and then develops and implements strategies to address them. It also plays an important role in the implementation of occupational standards within the Framework for Workforce Skills Development and Recognition (*Mise en œuvre du Cadre de développement et de reconnaissance des compétences de la main-d'œuvre*), including the development of continuing education in businesses and the identification of specific needs with regard to human resources and work organization. At the behest of Emploi Québec, the CSMOs have also been responsible for establishing evaluation criteria for "competency recognition" (*reconnaissance des compétences*), namely, the recognition of skills acquired on the job as distinct from competencies developed within vocational programs (Moss, 2018, p. 54).

9 The threshold has been changed on several occasions in relation to political pressures, and is currently fixed at an annual wage bill of two million dollars (Emploi Québec, 2021).

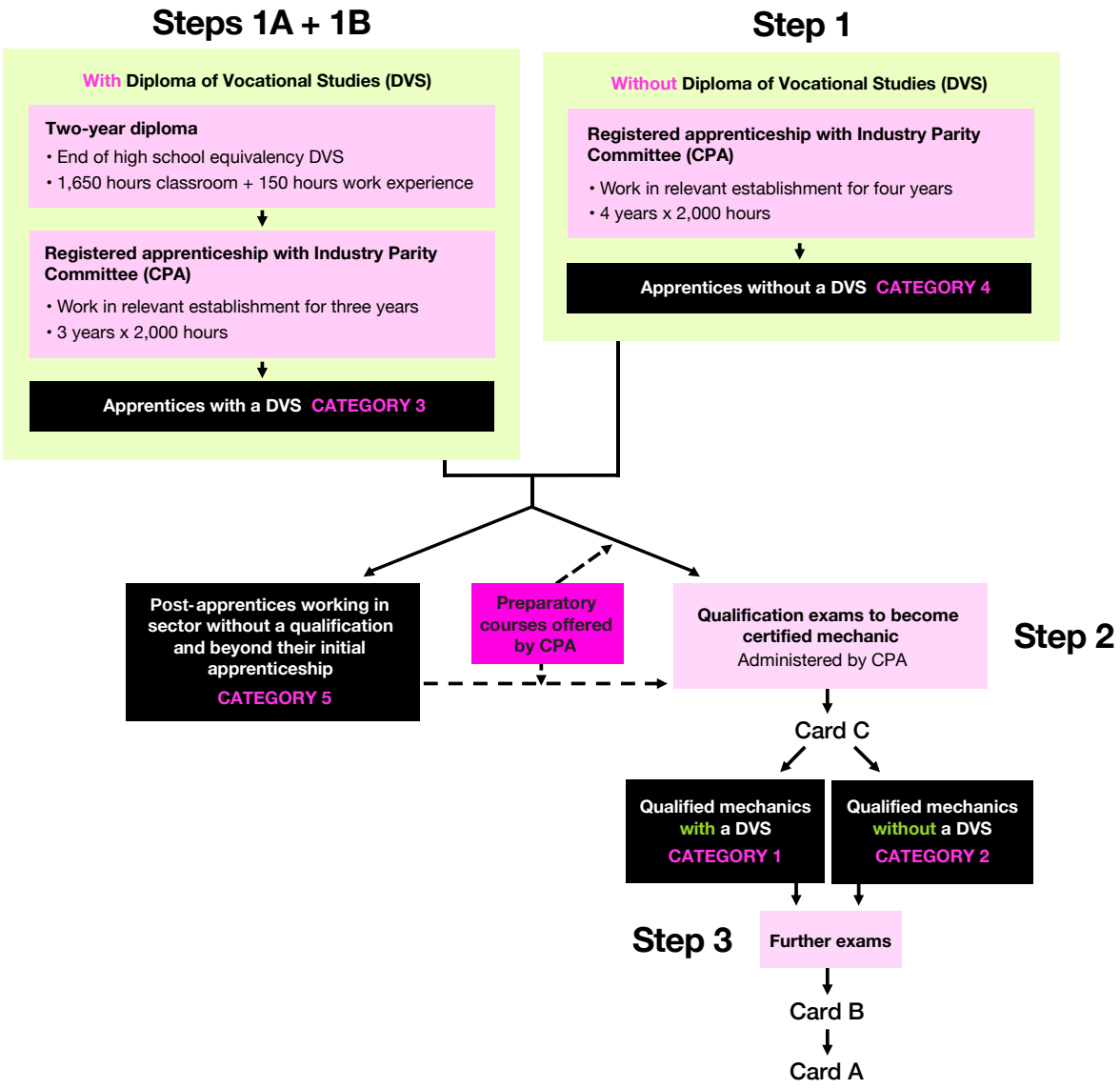
It should be noted that CSMO-Auto and the CPAs mobilize many of the same associations and individuals. The auto services industry in Québec is characterized by a thick institutional density, as well as a rich tradition of social dialogue related to labour market and workforce development. Many actors identify more readily with one institution than the other. Some employers express reticence about the union presence in the CPAs, yet ironically often work with the same unions in CSMO forums. It is within and between these institutions that there is ongoing negotiation about the terms of skills settlements in this industry. In contrast to top-down, market-led approaches to the provision of skill, Bélanger and Hart (2012) highlight the importance of localized and highly contextual approaches to skills development. Indeed, it has been argued that such an approach offers a more grounded approach to skills issues, with industry stakeholders being deeply involved in the identification and resolution of skills challenges in their regions.

The Québec auto services industry is thus governed by a complex, interconnected architecture. There are multiple stakeholders seeking to respond to the rapid technological transformations occurring in the industry, which is reflected in Québec's training ecosystem. First, vocational schools provide a basic "diploma of vocational studies" (DVS) training to new and potential entrants in the industry. Second, training is provided by key industry stakeholders (see Figure 4 on the anatomy of the sector). Manufacturers—concerned with the knowledge, maintenance, and repair of their products—frequently organize training for employees in dealerships, which can be mandatory for technicians performing work under warranty. Parts distributors increasingly provide training in aftermarket workshops to customers (auto service technicians and their employers) who are installing their products; their motives include customer loyalty, more effective usage of their products, and limiting returns of the parts they supply. Banners will also provide ongoing training to their franchisees, as needed.

Third, school boards and vocational training schools arrange corporate or firm services to provide training on particular issues, which are in turn federated in a provincial service (Formation Québec en réseau). Fourth, health and safety training is provided by Auto Prévention, a specialist association concerned with this issue. Fifth, CPAs provide direct training to prepare for qualifying exams and, increasingly, have developed specialist courses to meet skills gaps and future skills challenges. Sixth, CSMO-Auto organizes targeted courses to respond to particular needs, such as in automobile sales. Finally—and most often with the financial support of the CPMT—several of these bodies and stakeholders collaborate in the development of particular training initiatives in order to address skills shortages and future issues (e.g., electrical vehicles). There is also a wide range of training specialists and consultants who intervene and provide their services within this training ecosystem.

FIGURE 6

How to become an auto service technician in Québec: Two pathways, multiple categories



Source: Created by authors.

Multiple categories and pathways to becoming an auto service technician

The next portion of this section shifts the focus away from the institutions and stakeholders concerned with training, toward the individual workers who are receiving training. In particular, this section will focus on auto technicians and mechanics in the auto services industry in order to situate these key workers and better understand their training challenges in adapting technological change.

On the basis of ongoing exchanges with industry stakeholders, we have identified five categories of technician and investigated their different pathways. It is first necessary to distinguish between those who enter the industry with a DVS and those who do not. It is also important to differentiate between those who go on to take and succeed in their qualifying exam, and those who do not. Figure 6 provides an illustration of these pathways, highlighting the following categories:

1. QUALIFIED MECHANICS WITH A DVS

These auto mechanics undertake the following trajectory:

1. Two-year vocational training with a diploma of their trade (DVS).
2. Three-year on-the-job apprenticeship (compensation at the rate of minimum wage for apprentices).
3. Success in the qualifying examinations administered by the CPAs if they are located in an applicable region.
4. Obtain a Class C certificate of qualification upon successful completion of qualifying examinations.
5. Obtain a certificate of superior qualification after passing the qualifying examinations—this certificate can be Class A or B.

The initial training lasts two years, takes place in vocational schools or high schools, and is primarily classroom-based (1,650 hours) with a small amount of on-the-job experience (150 hours).

After completing this program and obtaining their DVS, these technicians enter the auto service sector as apprentice mechanics. Their DVS gives them a credit of 2,000 qualifying hours at the outset of their apprenticeship. They complete a three-year apprenticeship (6,000 hours) for which they are typically required to purchase their own tools, with an income tax credit available for this expense. Their wages are not much higher than the minimum wage, especially if they start their career in the aftermarket.

At the end of their third year, apprentice mechanics can write the qualifying exams, which are held in most regions by a bipartite body (e.g., the CPA or parity committee that brings together employer and union representatives from a given region). If the applicant passes, they receive a trade card that is valid for the rest of their career.

There are three classes of cards (A, B, and C).[10] The entry-level card is C. Subsequent qualifying tests (one year after the initial exam) allow the C cardholder to apply for a higher-level card (A or B). Generally, those with higher-level cards will receive larger salaries. The decree system also provides standard salary progressions for workers who hold higher-level cards, whereas for some employees, especially in non-unionized workplaces, salary scales can be less predictable. When faced with chronic labour shortages and skill gaps, employers will expend considerable effort to retain and attract the skills they most need—and not always with a mind to an orderly salary progression. Thus, it should be noted that skill classes have little impact on wages, except in unionized workplaces where collective agreements tend to regulate such progression and its impact on wages.

2. QUALIFIED MECHANICS WITHOUT A DVS

These mechanics, who hold a C card or higher, are comparable in all respects to qualified mechanics with a DVS—except that

10 Some regions label these qualification card classifications as 1 (A), 2 (B), and 3 (C).

their initial entry into the trade is through an on-the-job apprenticeship, without any previous vocational training. They complete a four-year apprenticeship under the tutelage of a qualified mechanic who acts as their supervisor (requiring a total of 6,000 to 8,000 hours of practice, depending on the region). These mechanics generally share similar training trajectories: they learn by doing, typically must purchase their own tools, and must pass the same examination system as apprentices with a DVS. They are able to first obtain a C card, and then sit subsequent exams for A and B cards.

3. APPRENTICES WITH A VOCATIONAL DIPLOMA WHO ARE SERVING THEIR APPRENTICESHIP

These apprentice mechanics have completed their two-year vocational training before they can write the qualifying exams. Their 1,650 classroom hours during the DVS and their 150 hours of work experience count as the equivalent of one year of apprenticeship, for those who do not take the vocational diploma route. It is assumed that they will become qualified mechanics after they write their qualifying exams at the end of the apprenticeship.

4. APPRENTICES WITHOUT A VOCATIONAL DIPLOMA WHO ARE SERVING THEIR APPRENTICESHIPS

These mechanic apprentices are similar to those with a trade diploma, except they must complete a four-year apprenticeship (8,000 hours of practice) before they can write their qualifying exams. It can also be assumed that they will become qualified mechanics after passing their exams at the end of their apprenticeship.

5. POST-APPRENTICES WHO CONTINUE TO WORK IN THE SECTOR WITHOUT A QUALIFICATION AND BEYOND THEIR INITIAL APPRENTICESHIP

This group of mechanics is what we label “post-apprentices,” as they have completed the formal qualifications of their apprenticeship but have not proceeded to—or succeeded in—the qualification exams. Some of these post-apprentices have a DVS.

There is much to be understood about the differences between these groups and their varying training needs. The primary barrier for workers is certainly qualifying exams, but there are several scenarios that can cause difficulties. One of the following may apply:

> They are temporarily waiting for optimal conditions to take the exams;

> They plan to never take the exams;

> They lack particular technical skills and require compensatory training;

> They lack basic or essential skills, which may be an obstacle to most types of exams (and several training programs), and it is not evident how to overcome this basic skills gap;

> They lack the confidence to take either training or the exams;

> They have not benefited from strong mentorship and/or optimal learning opportunities during their apprenticeship;

- They lack relevant information on career progression;
- There is an absence of strong incentives to take the exams (e.g., salary, working conditions, employer or industry requirements, peer or employer encouragement);
- They do not want to take the exam because they will lose the tax credit for the purchase of tools;
- There is no compulsory requirement to take the exams;
- The employer discourages technicians from taking such exams because of the implications for the pay structure or for fear of losing competent employees with recognized qualifications;
- Work is organized in such a way that time or resources are not available for the necessary training to take the exams;
- The exams are targeted for generic industry skills, and the apprentice technicians are primarily skilled for particular brands or types of work.

Each of the five categories manifest different types of skills challenges:

- The first category (qualified technicians with a DVS) probably have the basis to succeed in continuing education, with the ability to respond to skills gaps and future skills challenges.
- The second category (qualified technicians without a DVS) often present the same characteristics as the first category but might not have all of the basic skills to meet the skills gaps and future skills challenges. Situations will vary on a case-by-case basis.
- The third category (apprentices with a DVS) are on a possible path to qualification; however, they do not necessarily qualify in the formal recognition of their skills. They require targeted training to guide them toward qualification, and their employers also require incentives to support them in this process.
- The fourth category (apprentices without a DVS) are most at-risk of being left behind by skills gaps and future skills challenges. They do not necessarily have all of the basics from workplace apprenticeships and, in the absence of exceptional ability or very strong mentorship, are unlikely to fill this void. These workers may slip into the fifth category, or even exit the industry despite their initial training.
- The fifth category (post-apprentices without qualification) appears to be growing in size, and best illustrates the growing skills gaps and future skills challenges. These workers need multiple targeted interventions for building confidence, addressing the significant gaps in their training, and addressing specific skills gaps and future skills challenges. They are career apprentices with little prospect of progression.

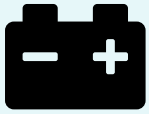
Addressing skills challenges

The auto services industry provides a good example of the increasing need to examine the links between changing business models and the skills ecosystem in Canada. Businesses traditionally rely on some combination of the market, the school system, and governments to provide the skills that employers require (Buchanan et al., 2017). In the Québec case, only a

minority of these workers typically qualified through vocational training schools; otherwise, they were recruited and trained on the job, often without acquiring any further vocational or professional certification.

Although many technicians eventually achieve these certifications—through their initial training or subsequent skills upgrades—only a minority of the workforce possesses these qualifications. Yet, in light of rapidly evolving technologies, there are both significant shortages of workers and important gaps in their skills. There is the question of whether a significant proportion of auto workers have the capacity to obtain formal qualifications. Data obtained through the CPAs highlight a real challenge with regard to rates of success. Most of the topics covered by these exams exhibit a high level of failure—the worst being in technology-intensive subjects such as engines, transmissions, brakes, and electrical systems.

Finally, while employers ostensibly have strong incentives to invest in training, or to reform the existing system, there are competing incentives between different companies. For some, not only has basic training not been properly adapted to new realities of the industry, but the sector also lacks the tradition of dual vocational training and on-the-job apprenticeships—which could represent an alternative to both basic training and direct entry in the labour market. Although some businesses complain about the lack of skills from new or existing workers, they are reluctant to invest in training because they may miss opportunities to hire scarce high-skilled workers in the labour pool and because they would have to ensure higher wages in the context of ever-greater competition between sub-sectors (e.g., between the aftermarket and dealers).



The auto services industry provides a good example of the ***increasing need to examine the links between changing business models and the skills ecosystem in Canada.*** *Businesses traditionally rely on some combination of the market, the school system, and governments to provide the skills that employers require.*

(BUCHANAN ET AL., 2017)

These are all elements of a classic training trap, which is hardly unique to auto service technicians in Québec. However, Québec has interesting resources to address the shortcomings of this trap, including extensive stakeholder engagement and institutional creativity in the search for solutions. Despite the barriers outlined above, recent years have seen a proliferation of new initiatives to resolve the skills shortages, skills gaps, and emergence of future skills. Of particular interest is how the Québec ecosystem has generated a compelling range of experiments and innovations on some of the key issues in training for auto services.

Training Innovations for Shortages, Gaps, and Emerging Future Skills

This section highlights recent innovations to meet skills shortages, skills gaps, and the emergence of future skills. These practical, actor-driven examples typically entail experimentation outside of traditional training repertories, emerging from a continuing dialogue within and between auto service industry institutions. Some problems involve crossovers between basic skills (literacy and numeracy); intermediary skills (knowledge of electrical principles); and technical skills (setting up, operating, and repairing machines and technological systems). These initiatives cover a large range of actors—whether from different sub-sectors (e.g., dealerships, aftermarket, and body shops) or from public and corporate backgrounds. Table 5 provides an overview of these different training innovations.

Meeting skills shortages: Initiatives aimed at attracting more qualified persons to the industry and improving the quality of their training

Work–study programs

Work–study programs (WSPs, or *alternance travail-études* [ATE] in French, often referred to as "dual training") seek to enhance the attractiveness of vocational training. WSPs provide full-time DVS or vocational training for students (typically in the range of 16 to 19 years of age, but also sometimes older students who return to the school system) to acquire experience and training in a relevant workplace environment. Such programs address major criticisms of existing training, offering more practical experience and remuneration in the context of their practicum. While such dual training is characteristic of some national systems (e.g., Germany), it has not historically been a feature of training in Québec; however, concerns about skills shortages is shifting industry reluctance to engage in this kind of training.

In fact, despite their obvious benefits, WSPs are not yet generalized in the industry and remain very much in an experimentation phase; this is partially due to problems in making the link between the requirements of vocational training centres, participating employers, and other institutions. However, the inability to fill vocational training spots has reinforced the need to enhance the attractiveness of these programs. There are a variety of experiments occurring across the province, sparking collaborations between vocational training schools, CPAs, particular employers, and (most importantly) the targeted financial support of the CPMT (for an example of such a program in the Mauricie region, see Côté, 2018). Yet the question remains: why must multiple stakeholders constantly re-invent such programs on an experimental basis, as opposed to institutionalizing their existence in a sustained way?

Supervision for apprenticeship training

To quote a fairly typical apprentice: "What's the use of doing an apprenticeship if all I do is change oil and tires?" As such, one initiative focuses on upgrading the pedagogical and supervisory skills of those who serve as mentors or supervise apprenticeships in the auto services industry. One participant described the approach as follows:

> *So, when we created the program, we did several things. First, we selected the technician in the workshop who was the most suitable to accompany a student. Second, we also created a set of specifications. So the student has to identify the services or repairs that he or she has done by themself, so to identify their development. Each specification done should also be signed by the workshop manager. And the schoolteacher walks around our workshops to make sure that the support is well done, and that the accompanying journeyperson talked to the student.*

The objective is to improve the quality of the supervision by the journeypersons who sign off on apprenticeships in order to make such apprenticeships more attractive, while also addressing the severe skills shortages in the industry. The region of Val-d'Or provides an example of such a program (Centre de formation professionnelle de Val-d'Or, 2017). As discussed above, the completion rate of apprenticeships is extremely low, with inadequate supervision being a significant contributory factor. This program thus aims to recruit the most suitable technicians for supervision and introduce a more systematic, task-based approach to help ensure that apprentices are engaging in the right kinds of task. This will be verified by the workshop manager and a teacher from the vocational school or training centre.

To further reduce barriers to entry, Canadian Tire has underwritten the cost of the tools provided to its trainees, which industry observers emphasize is a significant cost for new entrants whose wages are already comparatively low. This corporate initiative is also related to WSPs and has led to further local initiatives. For example, in one region facing severe labour shortage, Canadian Tire collaborated with the employers' association

and the vocational school to underwrite 500 hours of vocational training—thereby reducing the length of training by six months (from two years to one-and-a-half years).

Immigrant sponsorship programs

As discussed earlier in this report, in comparison with Ontario, immigrants are underrepresented among technicians in Québec, which is a contributory factor to the severe labour shortages being experienced. In the context of this study, a number of employer association representatives reported responding to skills shortages through the attraction of immigrants who already have the requisite skills, qualifications, and experience. For example, the Corporation des concessionnaires d'automobiles du Québec, an employer association for dealerships, has begun offering assistance for international recruitment to its members (CCAQ, 2019).

A good example is that of a particular employer in search of heavy engine mechanics working with immigration consultants and other intermediaries to attract workers from the Philippines to settle in Montréal and work for their firm. Other examples include mechanics in dealerships and body shop specialists from French-speaking North Africa (e.g., Tunisia) and Latin America (e.g., Colombia and Mexico). This is not merely a quick fix for skills shortages, illustrating the extent to which industry stakeholders—in particular, employers' associations of dealerships and body shops—have sought to respond to these challenges. Moreover, these industry specialists have begun organizing

*A number of employers reported **responding to skills shortages through the attraction of immigrants** who already have the requisite skills and qualifications.*

missions in different countries, assessing the level of competencies of candidates and supporting new entrants in the immigration and settlement process. Some express their skepticism with regard to this strategy, while others believe that it requires patience to work well:

> *Well, I agree with the immigration strategy completely. But it doesn't work right away. For someone who wants to bring people in from any country, it takes almost a year to prepare so that the immigrants get the right to work here. And after that, these people have to be trained. So we come back to the same issue.*

Meeting skills gaps and emerging future skills: Initiatives aimed at upgrading the skills of those already working in the industry

Partnerships between manufacturers and DVS programs in vocational training centres

One of the important criticisms of vocational training programs is that they often do not have the budget or qualified personnel to deal with the most recent innovations in motor vehicles. This is an important aspect of the skills gap. For many industry observers, the vocational curriculum is stuck in the past, including the tools and vehicles on which the students acquire their skills. Specialists ask how recent DVS graduates can acquire the relevant skills if they have never worked on the most recent technologies (as discussed in an earlier section of this report; see page 17). Moreover, with uncertain and variable enrolments, school boards are often reluctant to invest heavily in the programs and infrastructure required to keep students and their teachers up to date.

Some vocational training centres have sought to develop partnerships with particular manufacturers in order to benefit from the provision of up-to-date equipment. This can also result in increased access for vocational teachers to current motor training from manufacturers. These initiatives function as a two-way street: manufacturers provide money and technology to these centres, which in turn develop specific training programs for these enterprises and their dealerships. Teachers in DVS programs will be assigned to these training programs, and certain dealerships will then ensure that their technicians enroll in them. This type of collaboration addresses important communications and technological issues in the industry, as one DVS teacher emphasized about the importance of the links being developed:

> *That's the reason why we have someone in charge of the "Services to Enterprises," where we stand out. I think that the "Services to Enterprises" in a vocational training centre are essential for us… It's an open door between the industry and us. Through it, we can always see the evolution of the industry, every day.*

Electric Motor Vehicle (EMV) Training (Véhicules motorisés électriques)

One of the most important skills gaps concerns electric and hybrid vehicles, with Québec being one of the most advanced jurisdictions in Canada in the adoption of such vehicles (see Figure 5 on page 23).

A significant challenge is that auto service technicians, including journeypersons with recognized credentials, have not been trained to service and repair such vehicles. The most important on-the-ground initiative is the creation of a new course (105 hours) that focuses on specialized training in the maintenance and repair of hybrid

and electric vehicles. It is the result of an initiative by CAA Québec and a teacher at a major vocational centre in Montréal (École des métiers de l'équipement motorisé de Montréal, 2021) and includes extensive industry collaboration between key actors in the training ecosystem, including the École des Métiers de l'automobile and the school board to which it belongs; the CPA-Montréal and other CPAs (especially from the Québec City region); CSMO-Auto; and a number of other stakeholders including Auto-Prévention (a specialist health and safety body), the Association of Automobile Industries of Canada (AIA), and Formation Québec en réseau (a federation of school boards specializing in continuing education). This is one of the first courses in Québec—and across Canada—to focus specifically on hybrid and electrical vehicles. This program will become one component in a larger series of training opportunities offered by the Montreal School Board (Centre de services scolaire de Montréal [CSSDM]) through its specialized automotive services school (see the Attestation of Vocational Studies section below).

ACS training from the CEGEP de Saint-Jérôme

The Québec education system makes a sharp distinction between vocational training at the equivalent of high school-level leading to a DVS and specialist technical training at the college level known as a CEGEP, which leads to a technical college qualification (a *Diplôme d'études collégiales techniques* [DEC] or an *Attestation d'études collégiales* [AEC]).[11] For some industry observers, motor vehicles now present such a degree of complexity that they wonder: should there not be CEGEP-level training for auto service technicians?

In essence, it is argued that the new generations of vehicles and autonomous transport systems require more advanced qualifications than those acquired in a DVS program. Such an evolution would be comparable to technological transformations observed in Industry 4.0 (I4.0), in industries such as aerospace and metallurgy, where technicians acquire higher-level skills and greater competencies than those offered in DVS programs. To date, no such programs exist; however, the CEGEP in Saint-Jerôme has innovated by offering a program in the technical college, as opposed to in a vocational high school (CEGEP de Saint Jérôme, 2021). This program, which is similar to that developed by the CPA-Montréal, focuses on complementary training for electric vehicles.

11 It is important to understand this difference from the other Canadian provinces, where students going to university complete Grade 12. For those not following this route, they can either go into vocational education in a high school, or the equivalent program in a technical college. In Québec, students destined for university complete high school with Grade 11, and then enroll in a two-year program in a CEGEP before entering university. However, for many students interested in more applied or technical programs, they can enroll in a two- or three-year technical program at a CEGEP to obtain either a DEC or AEC. Some CEGEPs have developed well-deserved reputations for the technical abilities of their talented students (e.g., in the aerospace industry). Until recently, such programs have not existed for auto services.

The prospect of college-level training is controversial. One school of thought sees the development of so-called super auto service technicians as the logical extension of the need for skill sets grounded in mathematical and systems analysis. Yet others believe that qualified auto technicians have all the requisite skills to undertake service requirements for new generations of vehicles if provided with upgraded training and continuing education from a variety of sources. The key then is to ensure a robust training system to ensure a well-trained workforce. When considering this second approach, one observer stated:

> *There are people who would talk about their ideas that we need college-level technicians to fix a vehicle. But that is not true. Because a mechanic can do it, once he or she has the training, the judgement, and the autonomy to do it on their own and demonstrates a desire to learn more.*

The Attestation of Vocational Studies (AVS)

The Attestation of Vocational Studies (AVS; or *Attestation d'études professionnelles* in French) is a 645-hour course in the education system to help students meet the challenges of new technologies. It is the result of a partnership between the Montréal School Board, ACCESS (the adult training centre of the Commission scolaire Riverside on the south shore of Montréal), and the Ministry of Education. It is still in development but will eventually seek to aggregate a series of component modules, moving from basic skills (i.e., numeracy and electricity) to more advanced technical skills training (e.g., electric motor vehicles).

This supplementary course is meant to offer—for those with basic training or mechanics without basic training but sufficient workplace experience—the opportunity to overcome their skills gaps by mastering these new technologies (see ACCESS, 2021). However, some in the industry remain skeptical with regard to how the course connects with the realities of the workforce: "So, who is going to do a 645-hour training course during the day without pay, or a 645-hour training on electric vehicles in the evening? It's totally crazy."

Recognition of prior learning (RPL)

The push for recognition of prior learning (RPL, or *la reconnaissance des acquis et des compétences* [RAC] in French) in Québec has had a dual purpose: to recognize some form of accreditation for labour market participants who do not have formal qualifications (i.e. from the Ministry of Education); and to recognize the skills and equivalencies of immigrants who have been educated in other systems. While RPL has had variable uptake in Québec (Moss, 2018), the movement was readily embraced in auto services, as it is an industry characterized by the lack of basic training among auto service technicians (with 70% of technicians estimated to lack formal training, such as a DVS). As discussed previously, one of the major pathways to becoming an auto service technician is to enter the industry directly by undertaking an apprenticeship and, in the words of some, "hoping for the best."

RPL initiatives targeting a variety of occupations have therefore been designed to assess the skill level of these workers and certify their competency on the basis of their prior learning, with a view to formalizing their education equivalencies and ultimately pursuing a DVS. As several observers have noted, and as is also emphasized in official discourse on "reaching for your dreams," it is important to, at a very basic human level, acknowledge the sense of achievement of those with low levels of schooling by supporting them in obtaining recognition of their skills acquired on the labour market.

One example of such an initiative is the CPA-Québec working in tandem with the Québec City School Board (Commission scolaire de la Capitale) on a pilot project for mechanics. This project aims to evaluate the competencies acquired on the labour market compared to basic training requirements and to eventually deliver a certification from the Ministry of Education. In cases of failure, specific training can be delivered in order to help mechanics meet the requirements. Given the predominance of untrained auto service technicians in the industry, RPL initiatives are viewed as a promising way to address the skills gap (Ma vie mon métier, 2021). In particular, with regard to the growth of "post-apprentices," these initiatives can offer a beneficial route out of the shortcomings of having low education and no formal qualifications. As stated by one observer:

> *What I would recommend to young people is to do prior learning assessment and recognition. They call it the recognition of prior learning (RPL)… at the initial vocational diploma level (DEP), it recognizes what you already know and identifies what you don't know. And then we can give you the training you need to get certified.*

Another example comes from the CSMO-Auto sectoral body, which is working with the Corporation of Body Shop Workshops in Québec (Corporation des carrossiers professionnels du Québec [CCPQ]) on a provincial project that seeks to reduce skills gaps (CSMO-Auto, 2021b). This initiative is similar to that for auto service technicians. As expressed by one observer:

> *We're in a project with the sectoral committee (CSMO) and the banners so that we can get the diplomas for our body repairers, so they don't have to re-learn what they've learned. And they'll get their diplomas [with a DVS] by practising the trade. There will be a teacher who will observe them for a day to find out if the training modules correspond to what they know.*

A third example also comes from a CSMO-Auto initiative and targets salespersons (CSMO-Auto, 2021c).

Overall, these three RPL initiatives are grounded in the realities of the industry by mobilizing key stakeholders in upgrading technical skills and recognizing equivalences in skills and training, as well as providing complementary training to address skills gaps. In doing so, these RPL initiatives offer a way to reinforce a worker's connection with the industry and ultimately promote retention, which is incredibly important in the context of acute labour shortages.

Preparatory training for obtaining skills qualifications

The distribution of roles within the vocational training ecosystem in Québec auto services (and beyond) is characterized by significant gaps. Vocational training programs and centres, which are typically affiliated with specific school boards, focus their efforts on entry-level training for trades, as well as the occasional customized training for particular clients, whereas the CPAs are formally responsible for assessing qualifications. Although they do not officially fulfill a training role (other than offering "preparatory training" for the qualification exams), the CPAs have increasingly sought to fill an important training gap. As the rate of failure for qualification exams has drastically increased, the knowledge and training gaps for both basic and technical skills have become increasingly evident. Moreover, this has become more apparent in an industry predominantly consisting of workers without formal qualifications (without a DVS), which are not mandatory for workers in auto services in Québec.

These workers can accumulate experience and acquire skills equivalencies, but it is evident that they often lack enough training to attain formal recognition of their competencies. A number of CPAs have therefore endeavoured to fill this gap through training innovations. One practical example is the development of a 128-hour course by the CPA in Québec City (CPA Québec, 2021), which has also been disseminated to other regional CPAs. Some have labelled this program a "pre-qualification," as it seeks to address basic gaps in knowledge and training for those already in the industry (see for example CPA Montréal, 2021). Some CPAs work with independent trainers for program delivery, while others partner with local vocational training centres. These training modules cover a wide range of relevant subjects (e.g., brakes, engines, electrical systems), generally have a short duration (15 to 36 hours), and combine practical hands-on instruction with classroom learning. While originally conceived as a way to address the prevalence of failures in exams, this program has developed into a practical, ground-up way to address skills gaps. As one observer noted:

> *Now, parity committees (CPAs) mainly supply training to update people's skills, in the sense of skills required to succeed in the mechanic exams. As there are still 70% of people entering the industry who don't have an initial vocational training diploma (DVS), they enter the industry by learning by doing [on the job]. So, the CPAs are there to provide the basic training.*

Workplace Apprenticeship Programs (WAP) or Workplace Occupational Standards

The decree system discussed in the previous section—which applies standards to the recognition of qualifications for auto service technicians—is a veritable patchwork. It covers most regions and most workers (80% to 85%) in Québec, but not all regions; as such, some do not have a local CPA dealing with qualification and pre-qualification training. The Workplace Apprenticeship Program (WAP, or *Programme*

d'apprentissage en milieu de travail [PAMT] in French) seeks to address the problem of apprenticeships in the regions not covered by a decree, as well as specific occupations in related industries (e.g., technicians and salespersons for leisure and recreational vehicles, as well as disassemblers in the recycling industry).

In partnership with local employment centres—specifically, government-run training and workforce development centres—employers will match an experienced technician with an apprentice to ensure they can achieve workplace training requirements on specific skills. At the end of the training, the apprentice will obtain an attestation of the skills acquired and recognized through what is labelled a "professional norm."[12] As explained by one industry specialist:

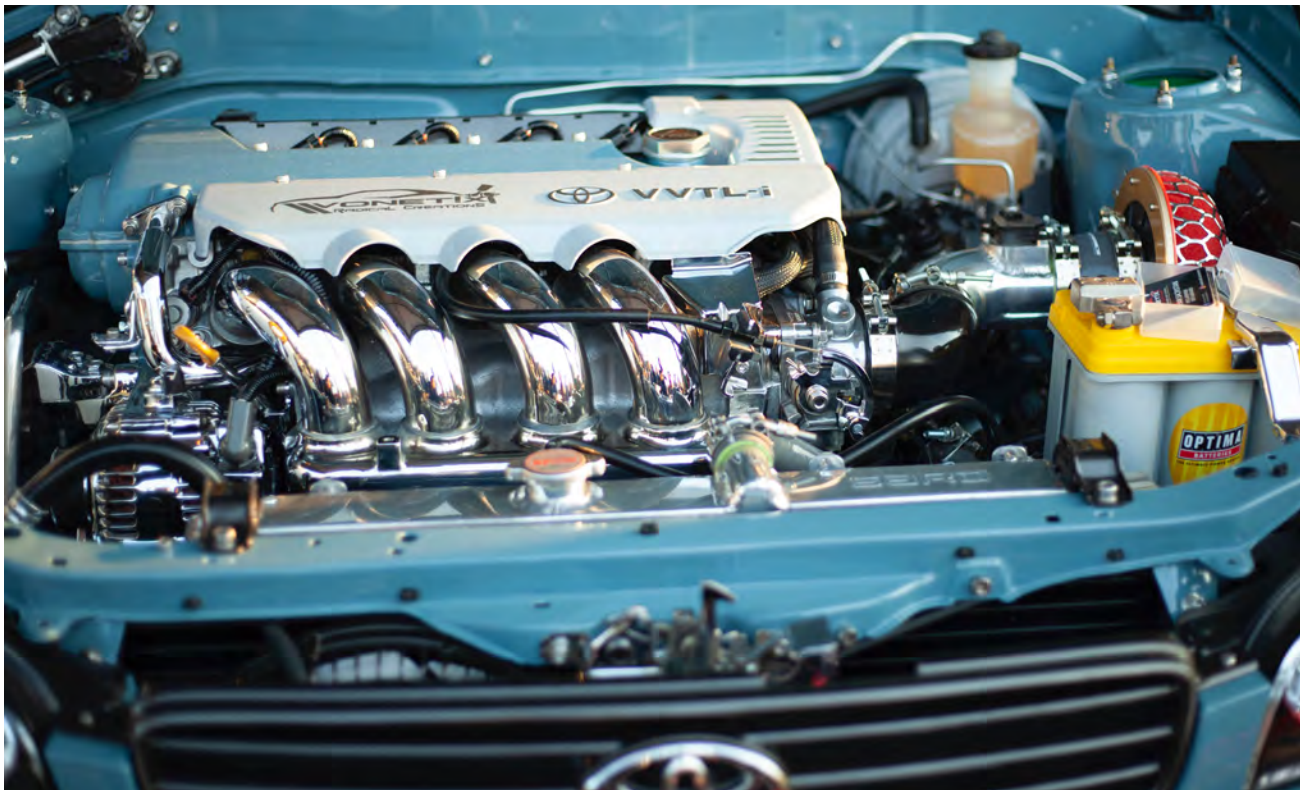
> *In our occupation, for example, there are ten essential skills. Then how does [the apprentice start to] work? The Local Employment Centre officer will meet the employer and sign an agreement with him. It costs nothing for the employer, except for the time, because it's the journeyperson in the workplace that will take care of the apprentice. So the employer will identify a journeyperson, and the journeyperson will have a "Journeyperson's Guide."*

12 For more information on LV and RV technicians, see: https://www.csmo-auto.com/parcours-metiers/technicien-de-vehicules-de-loisirs-20; https://www.csmo-auto.com/normes-professionnelles/technicienne-ou-technicien-de-vehicules-recreatifs; For information on vehicle salespersons, see: https://www.csmo-auto.com/parcours-metiers/conseiller-en-vente-dautomobile-28; For information on disassemblers, see: https://www.csmo-auto.com/normes-professionnelles/demonteuse-ou-demonteur-de-vehicules-routiers

Creation of training centres and training schemes

As the aftermarket contends with acute skills shortages and important skills gaps, some of the most prominent firms—notably among parts distributors—have begun enhancing their training initiatives. This has taken the form of new training schemes, curricula, and the creation of training centres, with the main focus being on technological transformations, primarily directed to their customers and franchisees.

In dealerships, the training and skills of technicians are constantly being upgraded through training provided by manufacturers. This training is sometimes compulsory, depending on the manufacturer and its brand management. The aftermarket faces similar skills gaps, but often cannot gain access to these sources of training from manufacturers, nor their proprietary technologies. These challenges have led actors in the body shop sector (e.g., FixAuto) and a number of parts distributors (e.g., Uni-select, Carquest, and Napa) to set up their own training centres or programs for some of their franchisees, affiliates, and customers. In business terms, training is a cost—but such costs can have returns on investment in other ways, such as brand loyalty, service differentiation, and customer satisfaction. Yet in contrast to the ability of manufacturers and their dealerships, the aftermarket has far less resources to spend on training—small franchisees often see it as a cost that their business model cannot easily bear. This is especially the case in body repair businesses, which are sometimes reluctant to invest in training, but nevertheless have a strong incentive to update skills, with



some certifications provided by insurance companies giving them access to a regular flow of work (e.g., Platinum- and Gold-Class body shops are certified by I-CAR and thereby recognized by insurance companies).[13]

The strategies in response to these skills shortages, skills gaps, and future skills challenges are an apt reflection of the complex architecture of the industry. Virtually all key stakeholders and institutions are involved in multiple skills and training initiatives. These stakeholders range from manufacturers and dealers to the various segments of the aftermarket. These industry actors also create collaborations with employer associations, educational associations, consultants, trade unions, and consumer associations. The major sectoral institutions in Québec (i.e., CSMO-Auto, the regional CPAs, and the provincial-level CPCPA) are all deeply involved, in multiple ways and in multiple initiatives. Moreover, this rich density of partnerships and innovations around skills and training highlights the important role of stakeholder engagement and social dialogue in skills and training innovations in the Canadian auto services industry.

13 The Inter-Industry Conference on Auto Collision Repair (I-CAR) sets industry standards for collision repair. I-CAR Canada is a training and recognition program run by the Automotive Industries Association of Canada. It focuses on skills updating for this industry.

TABLE 5

A portrait of training initiatives to address shortages, gaps, and emerging future skills in the auto services industry in Québec

Type of Initiative	Description
Initiatives to address skills shortages	
Work–study programs (WSPs)	Students undertaking basic training can engage in a paid workplace internship that is part of the learning program.
Supervision of apprenticeship training	Training for experienced technicians to mentor apprentices, workplace training for DVS students, and subsidies for apprentice work tools.
Immigrant sponsorships programs	Identifying, selecting, and recruiting immigrants to work in the industry.
Initiatives to address skills gaps and emerging future skills	
Partnerships between vocational training programs (DVS) and manufacturers	Providing resources to DVS training programs and centres, with complementary training development for dealerships.
Electric motor vehicle (EMV) training	Training for auto service technicians already in the labour market to acquire skills on electric and hybrid vehicles.
DEC or AEC on electric vehicles	College-level (as opposed to high school-level) training on electric vehicles.
Attestation of vocational studies (AVS)	Attestation by basic training centres after a supplementary program on electric vehicles.
Recognition of prior learning (RPL)	Certifying acquired skills of workers with weak educational achievements who are already in the labour market, with a potential view to undertaking further vocational studies (e.g., a DVS).
Preparatory training for qualifications	Specific training offered by CPAs to help auto service technicians preparing to take the journeyperson (C) and superior class (A and B) qualification exams.
Workplace Apprenticeship Program (WAP)	On-the-job training and recognition of competencies through a certification of workplace apprenticeships.
Development of aftermarket training centres	Brands and banners that set up training centres to offer specific courses for addressing skills gaps to their affiliates and customers.

Source: Created by authors based on data obtained during the study.

Conclusion

Lessons learned from skills and training experiences in the Québec auto services industry

As motor vehicles increasingly resemble "computers on wheels," the auto services industry is facing profound disruptions. Traditional business models in the industry are being transformed, creating unique challenges for companies and their employees. There is a need to collectively understand the trajectories of skills and training, particularly in a sector that is characterized by strongly organized actors, institutional legacies, and different interests between stakeholders. The skills ecosystems in the auto services industry are in the process of being disrupted, which upsets existing "skills settlements" and often requires new dialogue and solutions between different actors. Yet new skills settlements are incremental processes that take considerable time to implement and are characterized by competing and converging efforts and goals.

While it would be possible to examine any industry to discuss the impact of such transformational technologies, our focus has been on auto services. This industry represents a critical case study of how these transformations affect organizational structure among stakeholders, as it is composed of many SMEs with strong competitive dynamics, patchwork training systems, huge skills development problems, and often low levels of education among its workers.

We have argued that the Québec ecosystem merits particular attention. First, it presents some of the prototypical skills issues facing other industries in Canada: *skills shortages*, even in the pre-pandemic labour market, where different industries are competing for similar sets of skills; *skills gaps*, where technology is drastically changing the products on which service technicians work and outpacing their skills; and *future skills challenges*, notably from the emerging climate crisis. With auto services being so central to climate transition, it will be a major public policy focus over the coming decade as societies tackle this major source of carbon emissions.

Second, the Québec skills ecosystem is characterized by a density of stakeholders and institutions with a history of social dialogue on skills and training. In some countries and regions, it is difficult to organize such dialogue because of the paucity of informed actors and relevant institutions, whereas in Québec, there is a rich and continuing tradition of dialogue between workers, employers, governments, training institutions, and other stakeholders. These long-standing connections demonstrate that significant responses to technological change require grounded and bottom-up dialogue. Finally, the Québec ecosystem has generated a wide range of training innovations in response to its skills changes. Actors in this ecosystem by no means believe that they have solved all of their skills challenges, but there is nonetheless much to learn from a detailed consideration of their efforts and initiatives. Our results indicate that skills settlements should be considered as collective solutions. Individual and ad hoc initiatives can have some positive impact but tend to generate incomplete responses to the skills challenges created by new technologies.

This analysis of skills challenges in the Québec auto services industry highlights both negative and positive aspects of navigating profound technological transformations. On the positive side, industry actors do have the resources and capabilities to invest in skills challenges. Their collective solutions can help to resolve various problems in a way that is well-grounded in the realities of their industry. Indeed, what is especially remarkable is how many different stakeholders are tackling, in their own ways, similar challenges. Moreover, most actors—including businesses and employers' associations—are convinced that individual and market-based strategies cannot easily overcome the challenges they face. This confirms our initial predictions: that skills and their development must be understood in their particular context, as opposed to a national "plug-and-play" strategy. Though initiatives are sometimes targeted to particular groups of workers or occupations, there is also a common conviction that the industry requires sector-wide strategies in which multiple actors and institutions are pulling in the same direction. Skills are collective goods that are curated over time as the result of "skills settlements," which are themselves the product of actor and institutional interactions over time.

*Significant **responses to technological change require grounded and bottom-up dialogue**. Québec has a rich tradition of such dialogue between workers and their unions, employers, governments, training institutions, and other stakeholders.*

On the negative side—or, at least more open to criticism—is the extent to which these multiple innovations and initiatives are actually cohering. Initiatives pursued by individual businesses are genuinely innovative, but there are questions about their effectiveness in the context of a larger strategy. The institutional strategies pursued by the CPAs and CSMO-Auto offer more collective capacity toward meeting some of the most pressing skills issues, as they result from extensive social dialogue and stakeholder collaboration. Yet these strategies are also often patchwork and subject to a complex system of ad hoc and targeted state subsidies, which are most often short-term and typically targeted to particular segments or regions in the industry. It would seem that more effective solutions could be more systematic and province-wide, such as increasing the quotient of technicians with basic training (DVS) and journeypersons' cards.

Finally, it is worth noting that these steps, albeit significant, are only initial forays into transforming training regimens in the auto services industry. The skill requirements are changing so quickly that—drawing on the many initiatives currently under experimentation—a robust system of continuing education must be available to all workers, irrespective of their initial training and their degree of qualification. There is much evidence that new skills settlements are currently being developed by various actors in the Québec auto services industry, but that the design and dissemination of training best practices require a stronger impetus and greater coherence in order to rise to the difficult challenges faced by companies and employees alike.

Appendices

Appendix A: Description of Quantitative Data

Automotive service technicians or body repairers

The Census of Population, conducted every five years, provides detailed information on occupations. Two of these occupations—automotive service technicians (7321) and motor vehicle body repairers (7322)—are unambiguously located in auto services. Other occupations (e.g., sales) cut across industry codes and cannot be readily allocated by industry. We have therefore focused on calculating the approximate percentage of jobs in auto services occupied by auto service technicians and body repairers.

This estimation is possible by combining two sources from the most recent (2016) census data (Statistics Canada, 2018b). First, there is information available on the two occupations readily identifiable with auto services (Catalogue no. 98-400-X2016355). Second, there is information available on employment in the industry by NAICS code (Catalogue no. 98-400-X2016361). We use the data available for the same calendar year (2016) to provide an estimation of the relative importance of auto service technicians and body repairers as a proportion of jobs in the industry.

According to this Statistics Canada data, there were 432,590 jobs in automotive services in Canada in 2016, of which 103,240 were in Québec and 151,925 were in Ontario. The census data indicates that there were 154,720 service technicians and 29,175 body repairers working in the industry in 2016 (see Table 4 on page 33).

We therefore estimate that in 2016, automotive service technicians and body repairers made up 42.5% of those working in the auto service industry in Canada, 43% of those working in the auto service industry in Québec, and 42.6% of those working in the auto service industry in Ontario. These proportions appear quite stable across jurisdictions.

Automotive service employment for diverse groups

The Canadian Census of Population presented information by occupation (NOC codes in brackets), as well as demographic characteristics, both nationally and by province of residence. The census is conducted every five years, so the most recent data is from the 2016 census.

Workers include persons aged at least 15 years who worked part of the year (part- or full-time) or worked the full year (part- or full-time). “Full-time” is defined as 30 hours or more per week; anything less is “part-time.” “Full year” is defined as 49 weeks or more of work. “Immigrants” refer to persons who are, or who have ever been, a landed immigrant or permanent resident—including those born outside of Canada who have obtained Canadian citizenship by naturalization.

Appendix B: Research Methods and Overview of Interviews Conducted in the Québec Auto Services Industry

The analysis presented in this paper was developed from ongoing exchanges with industry partners and stakeholders (see Acknowledgements). Our research methods are primarily qualitative, yet complemented by secondary source data and descriptive statistics. This data has been captured from survey and census data from Statistics Canada and industry agencies for a quantitative analysis of sales, employment, and other industry trends.

In order to develop a comprehensive portrait of an industry in a state of technological flux, our study involved in-depth interviews with stakeholders and representatives from the auto services industry in the province of Québec. Interviews took place between July 10, 2018 and October 7, 2020. We conducted interviews with 105 individuals representing all manner of stakeholders in various segments of the auto services industry. Table 6 provides an overview of the range and types of stakeholders interviewed during that period.

Our primary industry partner, CSMO-Auto, helped the research team to identify an initial range of stakeholders in order to ensure comprehensive industry representation for our sample. As we learned more about the industry, we used snowball sampling to enlarge our interview pool, including roundtable discussions with particular groups of workers. The objective was to saturate our coverage through interviews with managers, business owners, and business associations; workplace sales representatives; mechanics and technicians and their trade unions; representatives from parity committees and institutions; civil servants from relevant ministries; technology and training consultants; and vocational training centres. Since the auto services industry is characterized by diverse sub-sectors—depending on the type of vehicle or specific activities—we covered all the main categories: dealers, aftermarket businesses, body shops, vehicle recycling, heavy-duty vehicles, parts distributions, parts manufacturing, and recreational and specialized vehicles.

Our semi-structured interviews, conducted mainly in French, were wide-ranging and typically lasted two hours in duration. Subjects covered include the nature of technological changes underway, their impact on business models and strategies, their impact on work organization and skills requirement, their impact on human resources and training strategies, and relationships between industry institutions and associations within the training ecosystem.

Ethical guidelines ensure anonymity and confidentiality for all respondents, which also allowed them to candidly share their views on the state of the industry and the challenges it faces. Of particular note is the passion displayed by the many stakeholders in this industry, and their generosity in sharing their knowledge and insights with the research team. Length restrictions prevent us from completely quoting their views, but ongoing collaborations with our research partner, CSMO-Auto, will produce further reports featuring direct interviews with industry actors. Note that quotations from these interviews, translated from the original French language, are used in this report to illustrate stakeholder views on key industry questions. To protect the identity of interview respondents, we do not identify the sources of interview quotations.

TABLE 6

Breakdown of interview respondents by stakeholder category in the auto services industry

Motor vehicle and motor vehicle parts and accessories merchant wholesalers (n=8)	
New motor vehicle parts and accessories merchant wholesalers	7
Used motor vehicle parts and accessories merchant wholesalers	1
Motor vehicle and parts dealers (n=16)	
Automobile dealers	12
Other motor vehicle dealers	4
Automotive repair and maintenance (n=19)	
Body repair	10
Mechanical repair and maintenance services	9
Institutions, associations, and other actors (n=62)	
Parity committees and social dialogue mechanisms	18
Employer associations	11
Consumer associations	5
Ministries	4
Vocational training centres	5
HR/Training consultants	7
Trade unions	5
Other actors (e.g., insurers, technology intermediaries, vehicle parts manufacturing)	7
Total: n=105	

Note: Interviews were conducted until October 7, 2020. Further interviews have since taken place in the context of a larger CRIMT–CSMO-Auto project (see Acknowledgements).

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