Chapter 11
Professions, Knowledge, and Workplace Change: The Case of Canadian Engineers

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Sociologists define professions as occupations distinguished by their advanced education, expertise, and social status (Adams, 2020). Professionals are experts who draw on their knowledge, skill, and experience to provide services to clients, employers, and the public, in a manner that is safe and in the public interest. Professionals' fiduciary responsibilities, especially when embedded in regulatory regimes, distinguish them from other experts (Carr, 1999). In Canada, for instance, regulated professionals are legally required to practice in the public interest, and failure to do so can result in loss of license, suspension, or other disciplinary action. To provide the public with safe and effective services, professionals draw on a body of knowledge that is complex, combining scientific, rigorous and esoteric knowledge of facts, theories and principles, with practical experiential knowledge, or what Schön (1983, pp. 49–54) has called more tacit "knowledge in action." Where do professionals get their knowledge? Advanced training in universities and other settings provides fundamental principles, and theories, but these may be insufficient to tackle the complexity of real-world problems (Schön, 1983). Other knowledge is obtained through practice and experience, where reflective practitioners develop the knowledge they need to address the challenges that confront them (Eraut, 1994; Schön, 1983; Winch, 2016).

Because the sources of professional knowledge are multiple, many forces and social trends impact it: from technological innovations and new research discoveries, to regulatory change, globalization, cultural influences, political and economic trends, and organizational change (Freidson, 1986; Parding & Abrahamsson, 2010; Schön, 1983; Susskind & Susskind, 2016; see also Chap. 6 by Siebert & Windrum, 2023). These forces shape not only the content and application of professional

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knowledge, but potentially the relationship between professionals and their knowledge, and the acquisition of knowledge. In light of pervasive social change, professionals must be adaptable, applying existing knowledge to new situations, developing new knowledge, and engaging in continuous learning. Increasingly, professionals are subject to reaccreditation and continuing education requirements whereby they must provide proof of learning and skill enhancement to maintain their license or registration required for practice.

Despite this emphasis on continuous learning, insufficient attention has been paid to workplaces as learning environments for professionals. Professional workplaces traditionally supported professional learning, acknowledging benefits to service quality and innovation from employing professional workers with cutting-edge skills (Bucher & Stelling, 1969; Freidson, 1986). Yet, there are signs that this is changing, as the organizations in which professionals work are being transformed. Researchers have identified a confluence of trends in professional workplaces: rationalization including a rising concern for efficiency and lowering costs, larger firms with more hierarchical organizational structures, globalization, closer management of professional workers, and more accountability (Ackroyd, 1996; Cooper, Hinings, Greenwood, & Brown, 1996; Currie, Waring, & Finn, 2008; Muzio & Ackroyd, 2005; Ritzer & Walczak, 1988). The emphasis on efficiency would appear to limit the time and space required for professional learning and reflective practice on the job. These trends have implications for the development of professional knowledge, and the exercise of expertise. These trends also, I will argue, have implications for professionals' ability to meet their public interest obligations.

In this paper, I explore professionals' on-the-job learning activities and knowledge development through a case study of professional engineers in Ontario, Canada. Analyzing data from interviews with 53 professional engineers, I examine engineers' skill and knowledge acquisition, and especially their opportunities for on-the-job learning. I find evidence that professional engineers' learning strategies are shifting. Workplace change is making it more difficult for engineers to learn on the job. As engineers have traditionally acquired much of their knowledge on the job, the lack of opportunities for meaningful skill acquisition at work has potentially negative implications for professional knowledge development. Social change may be altering not only what is learned, but how it is learned, and the depth of knowledge acquired—with implications for engineers' ability to discharge their ethical responsibilities to the public and their profession.

Professions, Knowledge, and Workplace Change

Most workers possess expertise and demonstrate their proficiency on the job. Some sociologists argue, however, that professionals' knowledge can be distinguished from others', because of its application to important social matters like justice and well-being (Hughes, 1958), its status (Collins, 1990), and the way it has been institutionalized and regulated (Freidson, 1986). Social closure limiting access to

professional education and training is a source of professional power and authority (Freidson, 1986; Saks, 2012). Although a growing number of researchers argue that professionals are indistinguishable from other experts in the West today (Evetts, 2006; Larson, 2018), differences in status, institutionalization, and regulation remain. Professionals mobilize their knowledge in service to the public and commit to do no harm in the application of their knowledge and training. For them, it is not enough to be proficient; rather, they should mobilize their proficiency for the well-being of others.

Scholars have argued that a key characteristic of professional knowledge is its blending of esoteric theory and concepts with practical applications (Gidney, 2005; Jamous & Pelloille, 1970; Schön, 1983). Professional work requires the exercise of judgement and the ability to think flexibly and quickly to apply scientific knowledge in often-unique circumstances (Evetts, 2002; Freidson, 1986; Schön, 1983). The development of this knowledge requires time, reflection, and practice (Eraut, 1994; Gidney, 2005; Schön, 1983; Winch, 2014). Without such reflection, knowledge acquired on the job may be ephemeral and not be integrated into broader professional knowledge (Eraut, 1994). The exercise and utilization of knowledge also entails ethical judgments, requiring autonomy and reflection as well (Carr, 1999). Reflection, then, may be particularly important in fulfilling fiduciary roles, and balancing the interests of employers, clients, and others.

Because professional knowledge is complex, professional education has traditionally been broad, taking place in multiple settings (Winch, 2016). In Canada, for at least a century, professional training has combined post-secondary education with some on-the-job training, learning, and development (Gidney, 2005). Not only do most professional schools provide opportunities for practical hands-on learning, but many professions require a period of field experience before candidates can obtain their final registration or license to practice independently. Learning after licensure continues. In this manner, professionals acquire only some of their knowledge through formal education. Much of what they know they learn outside of professional schools—through practical experience on the job, as well as through other avenues.

Learning on the job, however, may be becoming more difficult in light of workplace change. Rationalization and globalization encourage a drive for efficiency that can subordinate professionals' goals and interests to the drive for profit and/or efficiency (Evetts, 2006; Ritzer & Walczak, 1988). In the language of new institutionalism, the logic of capitalist workplaces and public sector workplaces under new public management, with its emphasis on efficiency and cost-cutting, conflicts with the logic of professionalism, with its emphasis on collegiality, quality, and knowledge enhancement (McGivern, Currie, Ferlie, Fitzgerald, & Waring, 2015; Reay & Hinings, 2009). In these new work environments, professionals are more closely managed than before (Ackroyd, 1996; Cooper et al., 1996; Currie et al., 2008; Evetts, 2006), and they may resist or adapt to managerialist norms (Currie et al., 2008; Noordegraaf, 2007, 2015).

"Deteriorated learning conditions" for professional workers may result (Parding & Abrahamsson, 2010, p. 300). Workers have less time for learning on the job, and less time for reflection about what they learn. Moreover, their learning is be guided

less by the profession and more by managers. This can be problematic because managers' goals respecting professionals' knowledge acquisition may differ dramatically from professionals' (Parding & Abrahamsson, 2010). In several sectors, the trend is to promote the development of "learning" organizations in which knowledge sharing and knowledge management become part of the culture (Alvesson & Kärreman, 2001; Currie et al., 2008). However, as Currie et al. (2008) argue, the "learning" in these environments is aimed at meeting managerial goals for efficiency, often by capturing and co-opting elements of professional knowledge, decontextualized and simplified. In such contexts, the push towards "knowledge management" can manifest as efforts to control knowledge workers, and even separate knowledge from the workers who possess it (Alvesson & Kärreman, 2001). In essence, new managerial practices generate mechanisms of control, whereby managers seek to capture and delimit professional knowledge, expertise, and even professionals' ability to learn (Alvesson & Kärreman, 2001; Currie et al., 2008; Parding & Abrahamsson, 2010). Although such initiatives are contested (Currie et al., 2008; McGivern & Ferlie, 2007), some professionals may be in a better position to resist than others. Managerial efforts to co-opt and alter professional knowledge combine with other trends to exacerbate the commodification of knowledge (Grace, 2014). These trends privilege the advancement of knowledge that enhances profit and efficiency, to the neglect of skill enhancement that benefits professionals or the public but does not raise quarterly returns.

Researchers have seldom explored international differences, but they may be significant in shaping these trends (Adams, 2015). Those studying hybrid professionalism and managerial influences on training are predominantly focused on Europe. Some European centres value investments in worker training. In Canada and the United States, the most striking trend may be the general decline in workplace training investments. Firms once willing to train workers, to invest in them and provide them with learning opportunities, now prefer to hire workers who already possess the needed skills (Hall, 2014). Firms are particularly reluctant to provide "portable" skills—ones that develop workers' capacities and which are applicable in a variety of workplaces, including their competitors'.

In Canada's highly educated labor market, employers may find little incentive to provide workers with training. There is a surplus of educated workers, over a third of whom are structurally underemployed—they have more education, skills, and knowledge than their jobs actually require (Livingstone, Adams, & Sawchuk, 2021). Livingstone (1998) explains that workers respond to a tight labor market and underemployment by seeking more skills on their own—pursuing formal and informal learning opportunities. In light of workers' willingness to obtain training at their own expense, the motivation for employers to invest in training falls (Livingstone, 1998). Employers may be able to get the workers they need without heavy investments in skill training.

The lack of investment in training may also owe much to specifically North American approaches to innovation and profit. Here, efforts to maximize profit and short-term gain discourage investment in long-term training and incremental innovation. American firms emphasize short-term investments for quick returns, unlike

some European counterparts who encourage more incremental gains, and practices of tinkering or bricolage. *Tinkering* is a process wherein employees seek to "improve their product continuously with whatever comes to hand and without checking the clock" (Glückler, Punstein, Wuttke, & Kirchner, 2020, p. 10). *Bricolage* is a term used to capture "resourcefulness and improvisation" among actors and workers (Garud & Karnøe, 2003, p. 278). Tinkering and bricolage involve time and space for innovation and learning by doing. North American work environments, including those employing engineers, appear to hold less space for incremental learning through tinkering (Garud & Karnøe, 2003), which to companies interested in maximizing short-term gains, has little immediate benefit, and hence can be cast as inefficient.

To summarize, previous researchers have argued that professionals are knowledge workers with fiduciary responsibilities and an ongoing commitment to knowledge enhancement and skill upgrading. Although professionals obtain their knowledge in part through formal education, practical experience is essential to knowledge and professional practice. Professionals acquire at least some of their knowledge through working; however effective workplace learning requires time for reflection (Eraut, 1994). As the environments in which North American professionals work change, there is reason to question whether these changes—rationalization, work intensification, increased managerialism—are conducive to professionals' workplace learning. Increased workloads, managerial scrutiny, and a focus on short-term gains and goals may leave little time for meaningful learning on the job. Given that professionals' learning and knowledge is intertwined with their ethical commitments to serve the public interest (Carr, 1999), such changes in professional practice and knowledge acquisition could negatively impact professionals' ability to engage in reflective, ethical practice.

In this paper, I explore the impact of workplace change on professional knowledge and learning through a case study of engineers in Ontario, Canada.[1] Engineers provide an excellent case for analysis for several reasons. Often at the forefront of technological innovation, engineers appear to be knowledge workers for whom ongoing learning is essential. Moreover, engineers are found at multiple organizational levels. Promotion into management is a common career path for engineers; hence, engineers have been "hybrid" workers, straddling management and professional practice, for decades (Brint, 1994; Raelin, 1986). Such traditional career paths could shape learning practices. Additionally, engineers are employed in a variety of different organizations—from large multi-national corporations to smaller professional service firms, and self-employment, in the public and private sector alike. This diversity of organizational settings can help shed light on the significance of organizations and organizational change to professional knowledge and learning. Finally, engineers must adhere to a code of ethics which requires that they place the public interest ahead of employer, professional, or even client wishes.

[1] In Canada, professional engineers are regulated at the provincial level, and all branches of engineering are regulated together, governed under one act and one regulatory body (per province).

Failure to adhere to this standard could result in disciplinary action. The overarching research questions are as follows: How have changes within Canadian engineering workplaces impacted professionals' learning practices and opportunities? What are the implications of these changes for professionals' ability to practice in the public interest?

Data and Methods

In my research, I draw on data from a broader study of professions and workplace change in Canada (Livingstone et al., 2021). I have focused this particular case study on professional engineers based in Ontario, Canada, and utilized key informant interviews, an online survey, and follow-up interviews with 53 professional engineers and engineering degree holders. The key data-source for this present analysis is the latter set of interviews, in which I focused on a wide range of issues, but paid particular attention to engineers' working conditions, workplace change, and their skills and knowledge.

I obtained ethics approval from a university ethics board and conducted the online survey between October 2016 and February 2017. Interested survey respondents could volunteer for follow-up interviews; 53 licensed engineers and engineering degree holders did so. Interviews were conducted in person, over the phone or over Skype, in the summer of 2017. The shortest interviews were about 40 min in length, while the longest was 70 min. Interviews were conducted by the author and a research assistant. As engineers are busy people, we conducted many interviews during lunch breaks or daily commutes, after work and on the weekends, or whenever engineers could find an hour or so to talk with us. Effort was made to obtain respondent diversity. We intentionally sought a cross-section of individuals across several dimensions, notably gender (40 men, 13 women) and age, employment status (10 owners or self-employed, 16 managers and 27 employees), and employment sector (41 private sector, 12 public or non-profit). We recorded and transcribed all but two of the Interviews, with participants' permission. I provide a summary of participant characteristics in Table 11.1 below.

We analyzed interview transcripts by hand. We first read the transcripts several times to see what key themes emerged. As knowledge, learning, and workplace

Table 11.1 Profile of interview participants

	Men	Women	Total
Private sector	31	10	41
Public sector	7	3	10
Non-profit	2	0	2
Self-employed	7	3	10
Managers	11	5	16
Employees	22	5	27
Total	**40**	**13**	**53**

Note. Source: Design by author

change emerged as central topics of interest, we undertook more focused coding. We extracted and placed in a separate file those portions of the interviews touching on knowledge, skill, or workplace change, and employed inductive, open coding to identify basic themes and codes within these areas. Subsequently, we undertook categorical coding to link together similar descriptive codes, and identify common themes and subthemes. As experiences varied, we paid attention to both areas of common experience across the range of interviews, and areas in which meaningful differences appeared. An example of the latter was whether a respondent was an employee, manager, or self-employed. What ultimately emerged was a complex story about the value of practical learning to engineers' knowledge, and the impact of workplace change on how and what they learned.

Findings

In interviews, engineers described changes to their learning practices and opportunities: (1) the rise of new organizational logics devaluing investments in on-the-job learning; (2) the impact of these changes on professionals' work and careers; (3) concomitant changes to how engineers learn.

Declining Investments in On-the-Job Learning

Canadian engineers argued that many employers do not invest in on-the-job learning like they did in the past. This is problematic because on-the-job learning is highly valued by Canadian engineers. In interviews, participants explained that their engineering education provided a foundation upon which they could build throughout their careers. Most respondents agreed with Macauley (employee) who explained that his engineering education was heavily theoretical and "provided a basis for critical thinking," and solid foundational skills; however, his practical skills were acquired "on the job." William concurred, stating that much of what he knows was "picked up on the job, through various training courses that companies sent me to, or just like stuff that I learned on my own just because it was interesting." Post-secondary education provides engineers with foundational knowledge, but they acquire much of the knowledge they use at work on the job.

In the past, engineers in Ontario had opportunities for learning through formal and informal apprenticeships. Quinn (self-employed), now in his late 50s, explains his experience on entering the job market:

> You started off in a two-year training program, where you would then go around a variety of different businesses inside the corporation … And then they heavily invested in your training. They would send you on training programs, anything. They'd either move you around, cover all your expenses, and so forth. Then I ended up working in one particular group, and then again, they were very oriented towards developing their professional peo-

> ple. So they saw you as their most important asset, and that's the way you were treated. You know, they paid competitive salaries. They trained. It was never a problem. Your boss's job—and this was a stated fact—was to facilitate your working and development.

Other older engineers described similar opportunities for formal apprenticeship programs, if they worked in larger companies, or more informal mentorships in smaller companies. Apprenticeship training ensured that engineers acquired the skills and practical training they needed. According to study participants, these programs have now largely disappeared largely because of new business logics.

Quinn dates the shift to the 1980s, when a series of mergers, take-overs, and corporate restructuring, altered the workplaces in which engineers work. Other engineers who had worked through this period provided similar accounts of small companies merging, and Canadian companies "bought by big U.S. conglomerates or European conglomerates" (Derrick, employee). Several changes affecting engineers' work and learning followed. Most-emphasized were growing specialization, work intensification, and a concomitant decrease in on-the-job professional development. These transitions have altered Canadian engineers' work, and as engineers do much of their learning on the job, they have altered how engineers learn.

For older engineers, perhaps the most striking change was the decline in apprenticeship, mentorship, and training. Established apprenticeship programs disappeared, and opportunities for mentorship dwindled. These programs came to be seen as a waste of money: "The apprenticeship program, it doesn't increase the profit, you know what I mean?" (Derrick, employee). Some companies viewed taking on younger workers and training them up as too expensive, or as an unnecessary expense. Engineer-manager Madelyn explains:

> It takes time and money to train somebody and it's … you know. If you're a very busy company with a heavy workload, you literally cannot afford to bring on a new grad and train them up, because it's actually going to be a distraction for your other people.

Engineer-manager Terence concurred that firms would seek to hire people to fill a specific role in a company, and "you can't hire someone who needs a little bit of mentoring." Much preferred was someone who had already worked for a few years: "they have a little bit more experience, they're going to work for the same amount of money as an intern, and you know, it's going to be a win-win … Everyone wins except the new graduate." As Terence indicates, the situation is particularly challenging for new graduates. Beck, a younger engineer employee, talked about how difficult it was to "find employment when you leave university after four years and you don't have any work experience." Most other new graduates concurred. Generally, participants agreed that even when engineering firms were searching for junior employees, they preferred those with at least a few years of work experience.

Not only was it difficult for young people to find a job with little experience, but they found it difficult to make that jump to full-time worker and gain the experience and knowledge to round out their training. Beck (employee) confessed that the transition from school was difficult: He felt "out of my league going into a workplace where I didn't know how engineering actually functioned in practice." Elizabeth (employee) lamented the lack of apprenticeship opportunities to provide her with

"that hands-on experience; you can figure out how to do stuff, you get trained in a technical discipline … When you graduate, what you don't know, you don't know." Without mentorship and investment, new graduates in particular found it challenging to develop their professional skills and knowledge.

Impact of These Changes on Professional Work and Careers

These trends did not just affect new graduates but shaped the learning opportunities and career trajectories of established engineers as well. In interviews, the latter lamented declining opportunities for on-the-job learning and training. For example, Derrick (employee) explained that previously at his company, "we somehow had training and there was more time for self-education and stuff. Today, no, because you have to charge every hour against the job." When asked about opportunities for learning on the job, Gabriella (employee) explained that her company was "too busy to spend any time on that … the work rate was very, very high, and it was really frustrating for me because we never spend time on learning and reading." Quinn (self-employed) very bluntly said that at the companies he interacts with the "training and development [is] at zero." Zoe (employee) concurred that "when they look to hire someone, [companies] want that person to have exactly the skillset they're looking for. They're not willing to train." In the past, there were opportunities to learn, engage in trial and error, and even tinker. Nowadays, this is deemed an inefficient use of engineers' time.

Companies were reluctant to provide in-house training. A few respondents talked about how there was little transfer of institutional knowledge where older workers passed on their acquired wisdom to others. Levi (manager) criticized his industry for a lack of "succession planning." which he felt was the result of "financial concerns." Although the benefit of succession planning might be "hard to see on a yearly budget track," he argued that a decade or two from now, it would be "well worth the investment". Older employees had "hard, hard, hard-earned knowledge"—he had sought some of this, on his own initiative, from a senior colleague who had taught him some tricks that made his work easier. Without such transfer of institutional knowledge, people would have to learn things "the hard way or the long way".

Indeed, several participants explained that their firms had a tendency to keep older workers in technical positions rather than promote them to management. Firms were inclined to keep the institutional knowledge where it was useful and promote more junior employees who had fewer technical skills (rather than expand their technical skill set). Consider these comments from Seth (self-employed):

> These [older] guys had been around for a very long time. And they were very knowledgeable, they were very competent at their jobs, but for some reason everybody wanted to keep them in their current technical positions. So, they would apply, one guy in particular, every year he applied for a management job and he would never get the job because, you know, he's basically, they want him in that one role and that was it.

One consequence of this was a lack of technical knowledge and experience among managers who were making key decisions. For Seth, this contributed to poor decision-making: "It's all part of the financial decisions being made by accountants, and they don't have an appreciation of technical work and of the technical skills required to do that." Yet, it may be that appreciation for older workers' technical skills, combined with an unwillingness to train newer workers in the same skill sets, explains the trends Seth identifies.

On-the-job training was particularly hard to come by, some contended, in large firms where engineers are seen as a cost of production or "a commodity." Quinn (self-employed) stated this directly: "I found that in these companies—particularly these large engineering companies—people are a commodity; your professional people are just a commodity." He elaborated:

> And that's the same way they treat people here. Like, you come in, they want someone to, you know, drive a blue car. They'll say, 'Get me a couple of blue car drivers.' Okay, blue car's done. They're going to do a red car. Do you train them to do a red car? No way, you just lay them off. Get rid of them. Find a red car guy. So people are viewed as—engineering people are simply viewed as—a commodity.

He continued to say, "A commodity, 'Hey, I'll just hire and fire at will,' because the cost is so little for me to do that and I really don't care." Emery (owner) agreed that companies see engineers as replaceable, and that training was not worth their while: "[T]he culture now is much more transactional and much less relationship driven." The attitude of others in his sector is that there is no point in training employees. He reports one colleague saying to him: "Why would I train somebody who is just going to leave in three years?" Emery provided his reply: "Well, what if they don't, and they stay?" His counterpart responded by saying, if he needs "a different skill set and they [a specific employee] don't have it, then I'll just find someone who does."

Delilah (self-employed) confirms that many companies "really are reluctant to pay for training." She indicates that this has been going on in Canada for decades.

> Whenever we ran out of resources … we would just, you know, poach from Europe quite often or wherever … highly, highly skilled engineers and really hands-on people from all over the world … We as an industry were too spoiled and instead of training our own people, we would go abroad and hire people from abroad. And so now companies are in the position where they are starting to realize that they have lost human capital.

As Quinn elaborates, "the idea is really, really simple: you hire somebody who already has been trained by somebody else"—whether in North America, Europe, or Asia. Linc (employee) concurs this may be a more typical attitude in a large company: "I just think that as a company gets bigger you tend to lose track of the value of employees because … every company focuses on profit because that's how the company stays alive." Many companies refuse to invest in training, because they believe they can find workers with the skill set they desire elsewhere, and bring them in, when and as needed.

If they cannot import the workers they need, then the other option is to export work to consultants elsewhere. So-called "high-value engineering groups" are low-wage engineering workers based elsewhere in the world (Quinn, self-employed).

The benefit to exporting work is that you do not have the expense of a full-time employee with benefits. Simon (owner) discussed the "reluctance to hire full-time permanent" as companies were trying "to do it as quickly and cheaply as possible, rather than have their own people learn how the thing works." Although he was critical of this mindset, as an owner, Simon saw the value in hiring someone with specialized expertise to do a task when needed, rather than training someone to obtain a skill that they may not use all the time. Emery (owner) agreed that hiring out was often the most efficient way of getting something done, although he also tried to learn from the experts when he had the opportunity.

Overall, engineer respondents recounted an increased reluctance among engineers' employers to invest in training. Engineers working as managers, as employees, and those who were self-employed all highlighted this trend. Still, these experiences were not universal. There were at least four respondents whose employers supported on-the-job learning. For example, Len (employee) worked in the public sector and argued his organization supported professional development and "allows us … to keep up with our knowledge." Linc (employee) worked at a private sector company where each employee had "a dedicated budget towards professional development; so, the company actually pays for it, and they will give you the time to do it." This was a marked improvement over his previous company. Moreover, some small firm owners and the self-employed argued that they built training expenses into the cost of their services, so that the expense of acquiring new skills was billed to the client. Such stories were comparatively rare among interviewees.

Changes to Engineers' Learning Practices

Despite Canadian employers' reluctance to train, many engineers recognized the need for "continuous training … whatever field you're in" (Derrick, employee). Moreover, participants emphasized the need for innovation, "lateral thinking," "brain mobility," and "thinking outside of the box" (George, manager; Linc, employee). Much of engineering work involved problem-solving, and new problems created new opportunities to learn. Some engineers had less latitude or autonomy, and hence had less scope for "lateral thinking," but even they had to learn new things. Where did they get their skills? Increasingly, they were left to acquire new skills on their own time, outside of work.

In interviews, engineers mentioned a variety of strategies to acquire skills and knowledge, some linked with work, and some outside. The most common strategies were experience, testing, and trial and error, followed by doing research (online or otherwise), reading on their own, and attending conferences. Also mentioned were webinars, lunch-and-learn sessions, local association meetings, workshops (especially from vendors selling products or services), as well as more formal courses. Several participants worked for bosses and organizations that actively encouraged professional development, but they were not willing to invest in it. Rather, employees were tasked to learn on their own time. Some were told directly by bosses and

mentors that it was their responsibility to spend time during evenings and weekends developing their skills:

> My boss says you should be doing at least a few hours of reading every weekend. (Caelan, employee)
>
> I encourage people to take an active view and an active investment, meaning spending their own time and their own money to build their technical skills, attend technical conferences, build their soft skills, communication skills. (Emery, owner)

Others simply did this work on their own time because there was no time to do it during work hours:

> You have to read the [new building] codes, study the code, and you have no time [at work]. You cannot charge it [to the customer] so you have to do it on your own. (Derrick, employee)

Gabriella (employee), who earlier stated that there was no time for learning on the job, also engaged in independent study.

Many found independent learning necessary to get ahead. Marcus (public manager, 46) was experiencing blocked mobility at his firm, so he was upgrading his skills in programming to improve his job opportunities. Milo (employee) worried that he was losing some of his engineering skills because his job was fairly narrow, so he studied in his spare time to keep some skills up-to-date. Margaret (manager) argued strongly that it was engineers' personal responsibility to keep their skills up-to-date. She was critical of those who whined about their companies' refusal to support training:

> If they're sitting there and looking and saying, 'Oh my God, I'm a victim, my company isn't investing in me,' well invest in yourself. If they're not spending—like I spent my own money to go to this conference … and my own vacation time.

She also argued that, through the internet and attending conferences, people could find mentors and role models. The message is clear: Whereas it used to be companies' responsibility to train their workers, mentor them, and develop their skills, it is increasingly workers' responsibility to acquire skills, mentors, and opportunities on their own time, using their evenings, their weekends, and their vacation time.

The implications for work-life balance (or lack thereof) are painfully clear to engineering employees, many of whom resisted (and resented) the fact that there was so little downtime:

> Sometimes I don't sleep as well. I mean I wish people would have mentioned this, you know, in school just as a reminder that you're entering a profession. You're not entering like a nine-to-five job where you show up and then you leave and then you don't have any obligation after that. You're always thinking about work. You're always taking work home with you to kind of get a head start on something. (Beck, employee)
>
> Driving home you think about it … In the shower, you think about it. (Derrick, employee)
>
> The company officially says life-work balance and then the manager says 'what life?' You know, like the president of the company. What life, you know? 'You go home and watch TV, what's that? No, you don't need any life.' (Derrick)

These changes—a lack of investment in training, and the individualization of training, combined with work intensification—have significant implications for

engineers' learning and knowledge. If engineers say that they obtain most of their skills and knowledge on the job, and yet have little time on the job for learning, and few companies are willing to invest in training, what are the consequences? With little time to invest in deep learning, people may be learning haphazardly, under pressure. As Baldwin (employee) argues: "The competitive environment … encourages people to do as little as possible in order to get the job and carry on." People end up learning in a hurry, and potentially on a more superficial level. Beck (employee) talked about the pressure he was under due to "ridiculous deadlines for projects":

> I think the short turnaround time on projects from start to finish is very stressful because you might not have some of the information that might make … the project turn out well. And when you're trying to turn things around in minimal timeframes it's very stressful because you're trying to cover everything you can and you don't—and you got obligations to your employer, to your client, to your fellow staff that you work with. But I feel as though it isn't a good practice … and I think that people would agree with that, most people, because that's how things can be missed, crucial details. And I mean that's, you know, where we get into issues [with] lawsuits.

According to Baldwin, Beck and other participants, the rushed learning people do under intense deadlines, is not only stressful—it may not provide the deeper understanding that would enable them to learn something well, and minimize errors. Recall that prioritizing public safety is a legal requirement for Canadian engineers. Work pressures that discourage knowledge building have ethical and safety implications.

Engineers who need to acquire knowledge quickly to meet deadlines or complete a task report turning to Google. When asked how engineers keep their skills up-to-date, Caelan (employee) replied: "They don't. They get pigeonholed and they go into management. They do a lot of reading and a lot of just Googling and personal skills dev[elopment]."

To the same question, Simon (owner) somewhat cynically replied "typically you Google it and for 90% of the time that's enough technical information to make a reasonable judgement in a field that you're not familiar with." Several engineers also talked about using Google Scholar to look up research papers, or explained that although Google searches provided information that was not always useful, engineers' education and prior training allowed them to separate the wheat from the chaff. Nonetheless, several engineers reported learning on-the-fly, trying to solve problems quickly through Google, conversations with others, and whatever they could find online in forums or research studies. These efforts to learn on the fly appear to represent "information management," rather than knowledge building (see Chap. 4 by Alexander, 2023). People acquire the information they need when they need it, without necessarily building a knowledge base.

Nevertheless, there was evidence of considerable learning on the part of engineers. Consistent with the literature (Noordegraaf, 2007, 2015), one area of focus was the acquisition of managerial knowledge. Several participants had returned to school to earn MBAs (Masters in Business Administration) or PMP designations (Project Management Professional) to solidify their progression into management

positions. Some of these participants had jobs that demanded both engineering and managerial knowledge, whereas others were more focused on managerial knowledge. In the public sector, engineers were disproportionately found in managerial positions, as many public sector organizations had outsourced their engineering: firing engineering employees and hiring them and others to do contract work, when needed. Management is a common career path for engineers, and it is hence unsurprising that many would seek to enhance their managerial skills to further their careers.

The other dimension of knowledge change interviewees emphasized was specialization. With specialization and technological change, engineering knowledge is expanding, but the ability of individual practitioners to stay on top of it (especially with less time for training) is decreasing. Veronica (self-employed) described the changes:

> I think there is more and more detailed specialties that didn't exist before. And so, I guess there's maybe in some areas more longer training periods to really get to be knowledgeable in that area that you can't, because there's so many of them, you can't possibly learn it, you know, in an engineering program. So, you know, on-the-job learning and continuous development is important.

Such trends are problematic as workers cannot learn all they need to know about specialities in school, but it is not clear that they have the time and opportunity to really acquire these specializations on the job.

Some participants expressed concern that engineers have a more limited grasp on the fundamentals than in the past. Certainly specialization was encouraged, but the changes also made possible 'dangerous crossover' (Palmer, self-employed)—where engineers might be tempted to work or give advice in areas that exceeded their areas of expertise (by drawing on Google or knowledge they were able to pick up on the fly). This increased the risk of "dabbling"—of practicing outside areas where engineers had strong expertise. Consider Simon's (owner) insights:

> There is more to know … Now it's less possible to cover everything and also there are more pre-packaged things that are appropriate to use rather than designing from scratch, there is much less designing from scratch. So you do have less of a broad knowledge, I think, in terms of sort of the deep structure but, on the other hand, what's available to you is larger. So … more specialized, yes, but in many ways I think it often might even be easier to sort of cross disciplines now.

The latter practice is controversial. Ethically, engineers should only work in those specializations where they possess knowledge, advanced training, and experience. Even though their license to practice is general, Canadian engineers are expected to stay within their area of specialization. Simon and a few others suggest this may become more problematic in the coming years.

Despite these reported trends, it is important to note that several engineers interviewed indicated that they were at the cutting edge of innovation, constructing new knowledge themselves, rather than following the instructions of others. For example, Palmer (self-employed) talked about "having to figure things out on our own, so it's kind of a new frontier." Not all engineers were experiencing rationalization and

managerialism. Those working with technology and those who were self-employed were particularly likely to report innovation. However, many others were not so fortunate. They reported difficulty in finding time on the job (and off the job) to learn, and potentially, a decline in the acquisition of deep knowledge—that which is concerned with underlying meanings and implications, rather than a superficial understanding of facts. Understanding the implications of one's actions is an important component of safe, ethical practice.

Discussion

Professionals are expected to mobilize their knowledge to serve the public, and practice in the public interest. To meet their fiduciary responsibilities, professionals should regularly upgrade their skills, and keep up with knowledge advancements. Traditionally, professional workplaces have supported professional learning, and even encouraged tinkering—continuous innovation through experimentation and practical work engagement. Recent workplace change in Canada may be altering the relationship between Canadian professionals and professional knowledge. Engineers report they have less time to learn on the job, and when they engage in work-related learning, they increasingly do so quickly and superficially to acquire what they need to know to meet pressing deadlines. They increasingly engage in information management, gathering data to complete a specific task, rather than knowledge building (see Chap. 4 by Alexander, 2023). Companies appear to be encouraging professional employees to use their evenings, weekends, and vacation time for knowledge acquisition. Many do this, but some resent how work demands expand to take up more and more of their time.

Knowledge scholars contend that knowledge acquisition requires time for reflection, and awareness of the implications of professional practice for the wider society. For example, Winch (2014, p. 56) argues that "underpinning systematic knowledge"—which he defines as "a combination of 'know that' and 'know how,' as well as acknowledging that reflection on elements underpinning knowledge can be a prelude to judgement and action"—underlies successful professional practice. Carr (1999) also explains that the exercise of knowledge requires autonomy and time for reflection on the ethical implications of practical decisions. In this light, one may question whether workers who have little time for reflection, exploration, or deep learning are prepared to exercise the best judgement in the conduct of their work, or develop professional knowledge in a manner that contributes to the public interest. This change could affect the quality of services and products produced, and ultimately have implications for public services and safety.

The concomitant trends of specialization, technological change, work intensification and commodification of engineers' skills are encouraging narrower, more specialist learning, and potentially more superficial learning. Although managers are not necessarily controlling the production and acquisition of professional knowledge, they are increasingly shaping what is learned, how it is learned, and the uses

to which that knowledge is directed. Knowledge acquired should directly contribute to profit or be covered under "billable hours." Other knowledge acquisition is cast as personal. Engineers, then, may continue to be proficient and acquire new skills, of use to their clients and employers, but without engaging in deep reflection. As a result, their practice may be less reflexive, with implications for public well-being. The ability of professionals, in this context, to fulfill traditional fiduciary responsibilities may be compromised (Grace, 2014).

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