THE DIGITAL SKILLS GAP BETWEEN NEW GRADUATES FROM ENGINEERING AND COMPUTER SCIENCE AND INDUSTRY EXPECTATIONS

A Literature Review created as part of the Building Capacity Through Competency Development Project: a partnership between the University of Victoria and Canada’s Digital Technology Supercluster, funded by the BC Ministry of Advanced Education and Skills Training

February 7, 2021

Prepared by Dana Prymak
# Table of Contents

About the Project............................................................................................................. 3  
Glossary of Terms ........................................................................................................... 4  
Acronym Glossary .......................................................................................................... 6  
Executive Summary ....................................................................................................... 7  
  Key Findings ............................................................................................................. 7  
  Search Approach ...................................................................................................... 9  
Identifying the Digital Skills Gap Between New Graduates from Engineering and Computer Science and Industry Expectations........................................................................ 10  
  A. Relationship between digital skills, digital competency, and digital literacy ........ 10  
  B. What is a digital skills gap? ................................................................................. 11  
  C. What are the main drivers of the digital skills gap? ............................................. 12  
    1. In-demand Hard Skills .............................................................................. 13  
    2. Emerging trends ...................................................................................... 16  
    3. In-demand Soft Skills ............................................................................... 17  
  D. Competency Frameworks ................................................................................... 21  
    1. The Coming Skills Revolution: Humans Wanted. How Canadian Youth Can Thrive in the Age of Disruption .............................................................. 22  
    2. I, Human: Digital and Soft Skills in a New Economy. The Brookfield Institute for Innovation and Entrepreneurship ......................................................... 23  
    3. 21st-Century Skills. World Economic Forum ................................................. 24  
    4. The Digital Engineering Competency Framework for the US Department of Defense .............................................................................................................. 25  
    5. Building Digital Capabilities ......................................................................... 27  
Conclusion .................................................................................................................... 27  
Appendix A: List of Engineering-related and Higher Education-related Sources ....... 29  
Appendix B: Key Search Terms .................................................................................... 30  
Appendix C: Equity and Skills Gap ............................................................................. 31  
Appendix D: Canada’s Growth Currency: Digital Talent Outlook 2023. The Information and Communications Technology Council ......................................................... 32  
Appendix E: Additional examples of Competency Frameworks ................................... 35  
Sources: ....................................................................................................................... 40
About the Project

This literature review was conducted as a part of the Building Capacity through Competency Development: A Partnership between the University of Victoria (UVic) and Canada’s Digital Technology Supercluster (“the Supercluster”) project. In partnership, UVic and the Supercluster aim to build capacity in the digital technology ecosystem by exploring innovations in work-integrated learning (WIL) that will develop a diverse talent pipeline and ensure a workforce prepared for the jobs of tomorrow. The purpose of the Building Capacity through Competency Development (BCCD) project is to three-fold:

1) To create an inclusive industry-based competency framework that integrates core competencies developed in a student’s discipline or field of study with job-specific competencies. This comprehensive framework will include the digital literacy and dexterity required to help the student be job ready in the emerging digital economy.

2) To build capacity, diversity, and inclusiveness in the digital workforce by increasing participation of underrepresented groups in WIL opportunities.

3) To identify initiatives and tools post-secondary institutions can provide to help employers with recruitment and retention of talent.
## Glossary of Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
</table>
| Competency                    | • Was first proposed in 1973 by McClelland. \(^1\)  
• “…an underlying characteristic of a person, which results in effective and/or superior performance in a job.” \(^1\)  
• “…combination of knowledge, skills, and abilities as well as experience to accomplish a specific task.” \(^2\)  
• “A competency is more than just knowledge and skills. It involves the ability to meet complex demands, by drawing on and mobilizing psychosocial resources (including skills and attitudes) in a particular context.” \(^3\)  
• “Competency is an ability to perform specific tasks well and to adapt easily to the activities of a variety of jobs.” \(^4\)  
• Vertical competency: “vertical proficiency focuses on how and why one delivers their work in the context of solving problems and working with others. It looks at behaviours, mindset, professionalism, emotional intelligence and cognitive framework.” \(^4\)                                                                 |
| Digitization                  | • “…the basic process of changing from analogue or physical format (e.g., paper records and texts, in-person lectures, physical models, ID cards), to digital form.” \(^5\)  
• Digitization is where technology turns physical goods and knowledge into data that can be easily replicated, shared, and stored. \(^6\)                                                                 |
| Digitalization               | • “…the process of using digital technologies and information to transform individual institutional operations (e.g., admissions, course registration, research administration, payroll, procurement).” \(^7\)                                                                 |
| Digital Transformation        | • “…a series of deep and coordinated culture, workforce, and technology shifts that enable new educational, and operating models and transform an institution’s operations, strategic directions, and value proposition.” \(^7\)                                                                 |
| Digital literacy/digitally-literate | • “Digital literacy means having the skills you need to live, learn, and work in a society where communication and access to information is increasingly through digital technologies like internet platforms, social media, and mobile devices. Communication is also a key aspect of digital literacy. When communicating in virtual environments, the ability to clearly express your ideas, ask relevant questions, maintain respect, and build trust is just as important as when communicating in person.” \(^8\)  
• In “Digital Literacy: A Conceptual Framework for Survival Skills in the Digital Era,” researcher Yoram Eshet-Alkalai defines “Digital literacy involves more than the mere ability to use software or operate a digital device; it includes a large variety of complex cognitive, motor, sociological and emotional skills, which users need in order to function effectively in digital environments.” \(^9\)  
• “…a person’s ability to perform tasks effectively in a digital environment [and] includes the ability to read and interpret media, to reproduce data and images through digital manipulation, and to evaluate and apply new knowledge gained from digital environments.” \(^10\)                                                                 |
<table>
<thead>
<tr>
<th>Digital skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>• “...evolving; involves critical skills, which grants the individual the possibility of exploring, expressing, criticizing, and understanding the flow of thoughts between individuals and collaborative groups or not in rapidly evolving technical environments.”¹¹</td>
</tr>
<tr>
<td>• “Skills are specific tasks that can be easily defined, practiced and improved.”¹²</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Digital competency</th>
</tr>
</thead>
<tbody>
<tr>
<td>• “Students arrive at university with some level of digital literacy, however, many do not how to apply digital literacy and its mastery in the educational context, especially to student learning.”¹¹</td>
</tr>
<tr>
<td>• “Digital competence comprises more than the abilities to use software or use a digital device; it involves a large variety of complex cognitive skills (CS) and ethical knowledge (EK), which individual need to function effectively in a digital environment (Ala-Mutka 2011).”¹³</td>
</tr>
<tr>
<td>• “the set of knowledge, skills, attitudes, abilities, strategies and awareness that are required when using ICT [information and Communication Technologies] and digital media to perform tasks; solve problems; communicate; manage information; collaborate; create and share content; and build knowledge effectively, efficiently, appropriately, critically, creatively, autonomously, flexibly, ethically, reflectively for work, leisure, participation, learning and socialising” (Ferrari (2012) p. 30).¹⁴</td>
</tr>
<tr>
<td>• “…competency is an ability to perform specific tasks well and to adapt easily to the activities of a variety of jobs.”¹⁶</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Immersive technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>• “...is a family of technologies encompassing all forms of computer-altered and extended reality (XR), including virtual reality (VR), augmented reality (AR), mixed reality (MR), and 360-degree video.”⁶³</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Industry 4.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>• “Industry 4.0 is a collective term for technologies and concepts of value chain organization”¹⁵</td>
</tr>
<tr>
<td>• Main drivers: Internet of Things (IoT), robots, Artificial Intelligence (AI), Cloud Computing, Virtual Reality (VR), Augmented Reality (AR), broadband Internet, emergence of new manufacturing technologies (nano, biotechnologies, 3D-printers, robots).⁸⁴</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Engineering Education 4.0⁸⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td>• “…it meets the requirements of Industry 4.0 where humans and machines amalgamate in order to open new possibilities.”</td>
</tr>
<tr>
<td>• “…it uses the potential of digital technologies, personalized data and open-source software.”</td>
</tr>
<tr>
<td>• “…it devises future education plans or life-long education: from early childhood to.”</td>
</tr>
<tr>
<td>• “…continuous on the job training which enables people to play a better role in the society.”</td>
</tr>
</tbody>
</table>
# Acronym Glossary

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>AR</td>
<td>Augmented Reality</td>
</tr>
<tr>
<td>BIM</td>
<td>Building Information Modelling</td>
</tr>
<tr>
<td>BPM</td>
<td>Business Process Management</td>
</tr>
<tr>
<td>ICT</td>
<td>Information and Communications Technology</td>
</tr>
<tr>
<td>ICTC</td>
<td>The Information and Communications Technology Council</td>
</tr>
<tr>
<td>IoT</td>
<td>Internet of Things</td>
</tr>
<tr>
<td>MOOC</td>
<td>Massive open learning course</td>
</tr>
<tr>
<td>NOC</td>
<td>National Occupational Classification</td>
</tr>
<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
</tr>
<tr>
<td>SLA</td>
<td>Service Level Agreements</td>
</tr>
<tr>
<td>VR</td>
<td>Virtual Reality</td>
</tr>
<tr>
<td>VUCA</td>
<td>Volatile, uncertain, complex, ambiguous</td>
</tr>
</tbody>
</table>
EXECUTIVE SUMMARY
Emerging technology is reshaping the future of work. One of the most important issues currently impacting the skills ecosystem in Canada is a shortage of skills to support rapid digitalization. Almost all industrial sectors rely on technology and demand for digital skills has been increasing more swiftly than supply. In a context of an unprecedented change, these developments place pressure on post-secondary institutions to quickly adapt curricula and work integrated experiences that prepare students for jobs that are rapidly changing. The purpose of the literature review is to gather existing research and literature on the skill gaps between workforce demands and engineering and computer science graduates.

Key Findings

1. The digital skills gap is impacted by complex connections between the rate of change, new drivers and mega trends.

The digital skills gap is more complex than commonly understood. Emerging technologies are changing faster than ever before and so are the competencies needed to do them. As technology continues to evolve, post-secondary institutions need to collaborate with industry to transform learning to swiftly and effectively equip learners with the competencies they need to maintain industry.

Digital skills are defined “as a range of abilities to use digital devices, communication applications, and networks to access and manage information.” While researchers and industry experts may agree on what is implied by digital skills, opinions vary regarding the origins of the digital skills gap. As the pace of change accelerates, new drivers and megatrends behind the skills gap transform more and more aspects of work. The interconnectedness between megatrends such as changing workforce demographics, underrepresentation of women and other groups, automation, digitalization, climate, geography, business model innovation, and emerging technologies are contributing to digital skill gaps.

2. New graduates need both professional and hard skills to succeed and remaining relevant in this fluid environment can only be met by lifelong learning.

As demand for digital skills increases, experts indicate that graduates need to possess soft and hard skills to adapt and thrive in a rapidly changing environment. One survey showed that 75% of respondents learned a new technology at least every few months or once a year. In addition to knowledge of several programming languages, programs and cybersecurity techniques, new
graduates need to understand and assess the capabilities, limitations, and potential threats of these systems.\textsuperscript{35,57,66,76,85} In order to develop such digital fluency, students need to be critical thinkers equipped with compassion, judgement, and skills to create responsible, transparent, and accountable systems.\textsuperscript{35,57,66,76,85} Many experts refer to this phenomenon as a hybrid or a T-shaped talent.\textsuperscript{65,68,69} The T-shape indicates both depth of expertise in one or more technical disciplines, combined with the breadth to understand, innovate and work across an organization with the ability to influence others, collaborate across disciplines, and develop creative solutions to complex business problems.\textsuperscript{65,68,69} The search for examples of digital competence frameworks revealed a diversity of thoughts and ideas among businesses and academics.

3. While there are many different competency frameworks, there are also many similarities between the frameworks.

The search for examples of digital competence frameworks revealed extensive work by the industry and academia. Ten frameworks identified in this literature review were centered on seven critical abilities: \textbf{Error! Bookmark not defined.}

- Comprehend and engage the digital environment
- Effectively create and consume digital information
- Communicate effectively
- Collaborate with diverse stakeholders
- Innovate rapidly/be an agile thinker
- Think critically/solve problems
- Maintain cybersecurity.
**Search Approach**

A review of literature was conducted using the search engine EBSCOhost and using a list of identified sources that were considered relevant to the topic (see Appendix A). For quality assurance purposes, only international peer reviewed research published in scientific journals, books, and industry-recognized magazines were included. The following four limitations were applied: 1) published between 2017 and 2020, 2) research written in English, 3) with full-text availability, and 4) study/research was conducted in North America. The search was later expanded to include Europe due to limited North American sources. The search terms used derived from both the author’s previous reading of literature in this research field and the use of terms frequently used in research specifically related to aspects of digital competence. These terms and their definitions are provided in Appendix B.

**Note to the Reader**

The language and nomenclature of digital skill gaps is described using different terms—such as, digital fluency, digital capabilities, digital competencies, digital intelligence, and digital literacy. Some authors use these terms interchangeably, while others emphasize the difference. Some of these definitions were compiled in the glossary provided on page 6. The most commonly terms identified in this review were digital skills, digital competency, and digital literacy.
IDENTIFYING THE DIGITAL SKILLS GAP BETWEEN NEW GRADUATES FROM ENGINEERING AND COMPUTER SCIENCE AND INDUSTRY EXPECTATIONS

A. Relationship Between Digital Skills, Digital Competency, and Digital Literacy

The relationship between skills and competencies has been defined by Organization for Economic Co-operation and Development (OECD): “A competency is more than just knowledge and skills. It involves the ability to meet complex demands, by drawing on and mobilizing psychosocial resources (including skills and attitudes) in a particular context.” Competence is seen as a way to achieve a degree of literacy. The Information and Communications Technology Council defines digital literacy as “the ability to locate, organize, understand, evaluate, and create information using digital technology for a knowledge-based society.”

The relationship between digital skills, digital competency and digital literacy has been summarized in figure 1.

Figure 1 Relationship between Digital Skills, Digital Competency, and Digital Literacy

Several authors use the concept in plural form – digital literacies – acknowledging new and diverse social practices of including information, digital, and new literacies.
competency and digital literacy are often seen as synonyms, digital literacy has been established first in the literature and used more frequently than digital competency. Many publications and studies point out the absence of a common definition which seems to impact policies and programs which are developed around the terminology.

B. What is a digital skills gap?
Rapid technological advancements place digital skills in an increased demand across many industries. The digital skills gap is defined as the difference between supply and demand for technical proficiency in the labour market. In other words, there is a great demand for candidates with proficiency in Information and Communications Technology (ICT) that is not currently being met. Among the most common skills implied by digital skills are Business Process Management (BPM), robotic process automation, cloud computing, emerging technology, agile program management, cybersecurity, and effective internal and external communications.

Although skills gap is not a new concept, much remains unknown about the extent and nature of a digital skills gap as it varies between industries. Many researchers and industry professionals agreed that digital skills are not a static set of skills but are continually evolving. The adoption of smart and connected technologies, such as the Internet of Things (IoT), will continuously reshape the future of work. To equip learners with the skills and knowledge required for future occupational success, post-secondary institutions need to emphasize that learning needs to continue after the completion of a formal credential. To thrive in the future, new graduates need to embrace the concept of lifelong learning. To remain relevant in this shifting economy, students need to enhance their skills through massive open learning courses (MOOCs) and stackable micro credentials while they work. The digital transformations present opportunities for productivity and efficiencies which will require employees to evolve and learn new skills as technologies and digital tools change throughout their career.

While numerous studies attempted to define digital skills, the matter of defining this phenomenon is complicated by the fact that the National Occupancy Classification system (NOC)—a system that classifies occupations in the Canadian labour market—does not define what skills and competencies are required for the job. One report suggested that the system is outdated, especially in the context of digital and technology-based occupations. For example, of the five most in-demand digital jobs in Alberta, four—UX/UI designer, data scientist, full stack development and backend developer—are not even currently included in the NOC.
Furthermore, the authors posited that the new emerging occupations were often mis-categorized and placed under categories that do not fully represent the essence of the occupation. One author suggested that most models and frameworks for digital skills, literacies or competencies fail to adequately address some of the megatrends and drivers that may be barriers to preparing more digitally skilled workers. Therefore, it is important to investigate what drives the digital skills gap.

C. What are the main drivers of the digital skills gap?

As mentioned above, since the gap is considered to be a result of the increased demand and limited supply of talent, many authors attributed the gap to the lack of fair compensations, poor recruitment and retention practices. While aging workforce is a unique characteristic of Canadian labour market, automation and digitalization are considered to be among the main driving forces behind the skills gap among CEOs and academics world-wide. Among other drivers commonly mentioned in the literature were Internet of Things (IoT), robotics, Artificial Intelligence (AI), Cloud Computing, Virtual Reality (VR), Augmented Reality (AR), broadband Internet, emergence of new manufacturing technologies (nano, bio-technologies, 3D-printers, robots), and big data analytics.

“Yes, automation eliminates traditional pathways to success but the technology enabling automation is creating entirely new career opportunities”

Jake Schwartz,
CEO of General Assembly

Nevertheless, some believed that the driving forces behind the skills gap were more complex. The interconnectedness between megatrends such as climate, business model innovation, demographic change, underrepresented populations, and emerging technologies are contributing to skill gaps. In order to prepare students for the future of work, all these trends must be considered.

Deloitte 2021 Engineering and Construction Industry Outlook indicated that a lack of employees who are fluent with digital technologies will further contribute to ongoing skill gaps. Employers were looking at the ways to incorporate building information modelling (BIM) and digital twins at every stage of the work flow: from the design stage to performance testing and remote project monitoring using sensors and drones. The Deloitte polls showed that 76% of
employers invested in connected technologies to address margin challenges, and 24% invested in drones and robotics to improve workers’ productivity and safety. Since digital transformation is becoming the core enabler of future success, companies will continue to search for new efficiencies, productivity-enhancing technologies and talent that can work with such technologies.

One report indicated that the shortage of digitally skilled employees in Canada prohibited companies from adopting new technologies. Small and medium-sized enterprises often have limited professional development funds and in-house resources to respond to fast-changing digital technologies. The lack of skilled workers who can assess and implement technological innovations prevents companies from adapting new technologies and increasing investments in innovation.

The repercussions of COVID-19 pandemic and associated system disruptions revealed deep disparities in people’s access to education and barriers to employment which has fuelled the skill gaps conversation. Some believed that the very same access to opportunities and elite networks is the driver of the skill gaps. The equity issues associated with skill gaps are out of scope of this review, however, some resources have been flagged for future considerations in Appendix C.

1. In-demand Hard Skills

To gain successful employment in the future, employees are expected to adapt and thrive in the VUCA - volatile, uncertain, complex, ambiguous environment. Ability to adapt to rapidly changing environments and roles is believed to be a key to the career success. Additionally, employees will be expected to learn new hard skills as well as soft skills. It is important to note that taxonomies for digital skills are changing as fast as the technology around us.

As a result of consultations with Canadian employers and job posting analysis, the Information and Communications Technology Council (ICTC) identified eight key digital occupations for the future and their critical hard skills. The majority of the skills were related to knowledge of specific coding languages such as Python, SQL, Java, C/C++,
Tableau, PHP and others. The detailed lists are available in Appendix D. In addition to the tools mentioned above, the Stack Overflow Developer Survey 2020 of 65,000 software developers from 186 countries found the Rust, Typescript, and Python programming languages to be the most popular languages. The most sought-after languages the respondents indicated interest in learning were Python, JavaScript, and Go. The survey showed that 75% of respondents learned a new technology at least every few months or once a year. In addition to programming languages, other drivers for new digital skills within the UK construction and infrastructure sector was BIM.

Some other skills that are believed to help narrow the digital skills gap were:

- Statistical and augmented analytics
- Cloud computing (cloud service level agreements (SLA))
- The cornerstones of IoT
- Data analytics
- Mechatronics (a combination of mechanical, electrical, computer, and controls engineering)
- Performance metrics (project performance)
- Remote, agile project, and program management
- Competitive vendor management (request for proposals, projects)
- Digital security and security management.

In addition to fluency in a wide range of tools and technologies, future graduates need to know how to deploy machine learning models and other data science outputs to power other business functions and products. In fact, one study found that one of the top roadblocks to production is the lack of skills in organizations to deploy models to production. When the study explored what students learned during their studies, it found several discrepancies between what organizations are looking for and the tools the graduates learn in the data science programs (see Figure 2). Big Data Management - the most sought-after skill by employers (see Figure 2) - is key to making important business decisions.

“So, it seems then that we are not programming a future of humans to code, but developing learners who are literate in adapting to change, navigating demand and understanding when and how to leverage digital assets when it’s vital to success. To apply or maintain the same level of flexibility in the realm of education or modern teaching frameworks, our digital literacy definition or methodology should allow for the ability to apply ICT in fields some believe to be foreign (i.e. history, geography etc.). However, if we challenge this traditional notion, we can quickly recognize how an interdisciplinary approach to ICT learning and essential conventional subject matter can blend in perfect harmony.”

Viet Hoang, Information and Communications Technology Council
programming skills, it includes data warehousing, computational frameworks, data mining, analysis, interpretation, governance, and administration.48 It is evident from figure 2 that while graduates might have some of the skills required to perform these processes, they needed to learn how to make connections between these steps on their own to succeed in the labour market. Although, the survey collected responses from professionals worldwide (with the majority being from North America), these findings are consistent with the results of the literature review.

**Figure 2 One Simple Chart: Skills gap in data science.** (2020, July 15). Gradient Flow.

**Do universities and other institutions adequately prepare data scientists?**

As AI, machine learning, and automation are playing increasingly large roles in workplaces, several studies noted a lack of advancement in cybersecurity skills gap.49,50 Given that hacking and ransomware attacks are on the rise, an acute shortage of experienced threat hunter, incident responder, or cloud security architect with advanced cybersecurity skills contributes to data breaches and loss of personal data.51 As cybersecurity technology and attacks continue to evolve, so will cybersecurity skills.52

While industry experts acknowledged that many non-traditional skills will become more prominent in the future (e.g., entrepreneurship, business skills), they also indicated that some of these skills have not been even defined.53,71 In order to keep up with the pace of technological progress, the training mechanisms in place must be nimble enough to adapt to these changing requirements.71 Acknowledging that some of the traditional post-
secondary degrees may take years, industry leaders suggested paid apprenticeship programs and micro credentials as a direct pathway to employment.\textsuperscript{1} Alongside traditional trade skill apprenticeships, some industries (IT, health care and cybersecurity) in the U.S. started to adapt the concept of apprenticeship programs to create a workforce that can achieve in-demand competencies and meet the necessary demands of the fast-paced, tech-driven future of work.\textsuperscript{55} A strong learning and mentoring culture is at the core of the apprenticeship program success.\textsuperscript{55} One survey showed that seventy-seven percent of participants in the apprenticeship programs had either taken a job with the employer where they did their apprenticeship or were still in the program.\textsuperscript{54}

2. Emerging trends

Given that some of the future skills do not exist, it is crucial to pay attention to emerging trends in the fields that are just gaining momentum and are expected to grow in the future. The adoption of AI in engineering and construction compared to other industries remains relatively low and is expected to grow in the future, albeit a few start-ups have introduced AI-focused approaches (image recognition, project schedule optimizers, enhanced analytical platforms).\textsuperscript{57} The main tech trends for 2021 in robotics field were making AI more secure and reliable, using AI in critical infrastructure, and utilizing AI for optimizing production processes.\textsuperscript{58} While AI and robotics are highly-anticipated technologies, there are others that can shape the future of work such as autonomous vehicles, distributed ledgers, additive manufacturing, Internet of Things, and immersive technologies.\textsuperscript{6} Emerging advancements in autonomous vehicles are expected to reconceptualize skills in some occupations, implying that daily requirements for certain occupations will look different in the future (e.g., mechanics and

\textsuperscript{1} Further research into differences between COOP and apprenticeship showed that some institutions in the U.S. started using the term apprenticeship instead of COOP. No significant differences between these terms were identified.
transit dispatchers skill needs will be different). Many of these changes will necessitate upskilling and/or reskilling. As a result of autonomous vehicle development and implantation, software engineers occupation will see an increased demand. Automotive advanced driver system engineers, automated vehicle research engineers, and autonomous vehicle trainers are among jobs that will become more popular as Canada enters autonomous vehicles market.

Climate change and demand for sustainable technologies is expected to increase and will require innovative approaches. One report found that for engineering construction to succeed in industry decarbonization by 2050, the industry required skilled individuals in CO₂ pipeline monitoring, production of synthetic fuels and repurposing of salt caverns for hydrogen shortage.

"Not a skills gap, but a learning curve"

Tyler Farmer and Mairead Matthews,
Information and Communications Technology Council

One of the studies conducted by the ICTC found that Canadian employers do not experience challenges accessing skilled talent. Since credentials on immersive technologies are relatively new and date back to 2017, the majority of currently employed are self-taught. The employers indicated they tended to look for someone who can learn new tools and applications as they are released. Whereas self-learning is likely to remain a trend, employers may expect more traditional post-secondary credentials such as bachelor degrees, diplomas and certificates in the future.

3. In-demand Soft Skills

"In highly technical roles, strong digital skills are necessary - but not at the expense of strong soft skills."

Viet Vu, Creig Lamb, Rob Willoughby,
Brookfield Institute
The BC Labour Market Outlook 2019 has identified the top five skills\(^2\) and competencies\(^3\) that will be necessary for future jobs (see Figure 3).\(^{12,64}\) No digital or tech-oriented skills were identified in the list. A partial explanation can be attributed to the fact that the forecasting models are built on historical data which in aggregate reporting might not signal emerging digital trends. The outdated methodology of NOC system might also impact the forecasting model behaviors. However, omitting digital skills might not be coincidental.

Soft skills are no longer considered an add-on to the technical skills.\(^83\) According to the Conference Board of Canada, the 21st century digital skills required technical skills that would enable one to work with advanced vehicles as well as the cognitive skills needed to work in digital environment. The Rising Skills report identifies seven core digital skills out of which the majority are soft skills: technical, information management, communication, collaboration, critical thinking, creativity, and problem solving.\(^65\) Another report on Canadian digital-ready public service also emphasized the importance of critical thinking and communication.\(^83\) Critical thinking and communication abilities were considered to be at the core of the ability to understand user needs, functional requirements and expectations, and to match technological solutions to the clients’ needs.\(^83\)

\[\text{"The digital skills gap goes beyond technical skills ... and includes business, marketing, and leadership skills specific to a digital world."}\]

\[\text{Taryn Oesch, Training Industry, Inc.}\]

---

\(^2\) According to the BC Labour market definitions, skill is an ability to perform task as a result of one’s knowledge, learning, or practice.

\(^3\) According to the BC Labour market definitions, competency is an ability to perform specific tasks well and to adapt easily to the activities of a variety of jobs.
Some argued that the nature of the digital skills gap was not as digital as it might be interpreted.\textsuperscript{66} In order to understand digital culture and digital working culture, learning leaders need to invest in a T-shaped or hybrid talent.\textsuperscript{37,66,67} The vertical T is a foundation of deep disciplinary skill.\textsuperscript{62,67} The horizontal bar of the T adds the breadth of skill necessary to work across an organization with the ability to influence others, collaborate across disciplines, and develop creative solutions to complex business problems.\textsuperscript{66} The T-shape symbolizes the fact that the technical knowledge has to exist before other elements; the horizontal part of the T can be added and explored throughout the career (see Figure 4).\textsuperscript{37} Soft skills (the horizontal bar of the T) require years of practice, while technical skills (the vertical bar of T) can be acquired quickly.\textsuperscript{68} Students also need to learn how to collaborate with data scientists, designers, customer service experts as companies develop projects to enhance customer experience with their products.\textsuperscript{44} Employee’s inability to effectively communicate, collaborate and interact with others could limit the employee’s future success.\textsuperscript{68} As the technological transformations continue, some expected that by 2030 digital skills gap might reverse the mentoring relationship.\textsuperscript{69} Younger employees might be asked to mentor older colleagues on topics such as technology and change management.\textsuperscript{69}

The hybrid trend is not new to the labour market. The Survey on Employment and Skills 2020 showed that when Canadians think about skills that are needed to succeed in the workplace, they spoke about technical know-how knowledge of a specific subject related to the job, followed by communication skills. Based on similar survey findings and job posting analysis, the Brookfield Institute for Innovation and Entrepreneurship drew readers’ attention to four prominent trends for hybrid roles:

- Combination of baseline workforce digital skills and strong interpersonal, problem-solving, and project management skills
- Proficiency in a variety of digitally intensive tools and strong interpersonal, problem-solving, and project management skills
- Knowledge of digitally intensive and augmented digital tools along with creativity, communication, design, and arts
- Advanced data skills as the work stream becomes more computerized.

The roundtable discussion of industry experts, academia and UK skills community acknowledged the importance of digital skills yet revealed the dangers of digitalization. Ethical concerns about digitalization vary from the use of AI in deadly military drones to increasing anxiety of unemployment and robots or chatbots providing medical advice. While AI’s contributions to incredible discoveries are undeniable, some scientists worry that the values, assumptions, and consequences that emerge with the new developments are not considered. For example, in 2014, Amazon developed a recruiting tool to automate the search process for software engineers. Shortly after the launch, the application began discriminating against women. It went unnoticed by the development team for almost three years; the application was completely abandoned in 2017.

“Engineers have the power to do tremendous good but technology can also be harmful. The ethics vision, if the profession adopts it, will ensure they think about public opinion and the public good – and in some cases, they might have to say ‘no’ to a project.”

Jim Baxter, Leeds University’s Interdisciplinary Ethics Applied Center

With increasingly present AI and robotic systems, ethical issues that come with adoption of these systems are complex. Before moving full-steam ahead embracing the latest technology, companies need employees who can help them analyse the consequences and impacts on the society and, at the same time, know the technology inside-out. Ethical questions around AI
and robots in medicine, law enforcement, military defence, data privacy, quantum computing, and other areas are profound and intricate. Understanding, authenticating and evaluating the capabilities and limitations of AI systems, what machines should and should not do, preventing AI from doing harm will be a critical skill. New graduate engineers have to be able to use skills like social intelligence, sense-making, design mindset, critical, convergent and reflexive thinking and virtual collaboration to recognize how information flows, shapes, and impacts the society in the era of social media (see Figure 5). In order to develop such AI fluency, graduates need to be equipped with compassion, judgement, and skills to create responsible, transparent, and accountable systems. Some manufacturing executives believed that the future of work will require humans to work alongside robots and machines to deliver higher efficiency and productivity. As AI continues to sprint past new milestones, future uniquely human activities, like empathy, building relationships and making sense of complex situations, will become even more prominent. The authors suggested that by 2030 the AI fluency will not focus only on coding languages, but higher-order thinking to understand the context facts fit within.

D. Competency Frameworks
The definition of competence by OECD captures the adaptive essence of this concept. Industry leaders agree that systematics, strategic, innovative, and collaborative skills required to transform business model and help an individual to thrive in a VUCA world must be at the core of the framework. The search for examples of digital competence frameworks revealed an extensive work done by the industry and academia. Ten frameworks identified in this literature review were centered on seven critical abilities:

- Comprehend and engage the digital environment
- Effectively create and consume digital information
• Communicate effectively
• Collaborate with diverse stakeholders
• Innovate rapidly/be an agile thinker
• Think critically/solve problems
• Maintain cybersecurity

Brief descriptions of five frameworks are provided below. More examples are available in Appendix E.

1. The Coming Skills Revolution: Humans Wanted. How Canadian Youth Can Thrive in the Age of Disruption

While this might not be considered a traditional competency framework, Royal Bank of Canada (RBC) has created a unique way of looking at the Canadian labour market, which might inspire educators and graduates to look at their skills differently. RBC’s The Coming Skills Revolution report divided the Canadian economy into six clusters based on skills: Solvers, Providers, Facilitators, Technicians, Crafters, and Doers. Engineers and computer scientists fall under Solvers (people who innovate and find solutions to intractable problems). Forty-five percent of working Canadians are expected to become solvers by 2021. The report stated that to be prepared for the future jobs, young Canadians need to be able to move between the clusters by taking short bootcamp courses.

2. I, Human: Digital and Soft Skills in a New Economy. The Brookfield Institute for Innovation and Entrepreneurship

Like the RBC report, the Brookfield Institute has grouped competencies into clusters that they expected to be in-demand in the future. The report suggested that in the future employers will be looking for a blend of digital and non-digital skills.

Since the NOC system does not offer an up-to-date classification of digital skills and occupations, the authors created a new system of assessing occupations and what level of digital literacy and knowledge are required for jobs. The system placed digital skills “on a continuum based on their relative digital intensity.” The general workforce digital skills (bottom left corner in figure 6), included in the most in-demand occupations across the Canadian economy, were the ability to use web-based project software, Microsoft Office, and accounting software. The second group included data skills (bottom right corner in figure 6) that focused on data collection and analysis, data modelling, Big Data, business intelligence as well as knowledge of specific tools such as Apache Hadoop, Tableau, and R. The third group - system infrastructure skills (top right corner in figure 6) -
consisted of digital infrastructure management ranging from setting up and managing cloud computing services to more general IT support. Proficiency in VMware, Windows Server, system administration and hardware and software installation skills were most commonly mentioned in this group. The fourth cluster (top left corner in figure 6) pertained to skills needed to generate of new digital web- and software-based products: Java, Python, software development, software engineering, and web development.


The fourth cluster that pertained to software/product development had the highest demand for hybrid occupations (e.g., AI project manager, AI sales manager; see Figure 7). As mentioned previously, the demand for hybrid occupations is expected to continue to rise.
A meta-analysis of research about 21st-century skills revealed skills that fall under foundational literacies, competencies, and character qualities (see Figure 8):

- Foundational literacies represent skills that serve as the base upon which students need to build more advanced and equally important competencies and character qualities.
- Competencies identified in figure 8 are essential to the 21st-century workforce, where being able to critically evaluate and convey knowledge, as well as work well with a team, has become the norm.
- Character qualities are crucial to discovering new concepts and ideas, having constructive interactions with diverse others, and demonstrating resilience in the face of obstacles.
4. The Digital Engineering Competency Framework for the US Department of Defense

Digital literacy and software literacy served as a foundation to the framework for the US Department of Defense. The four competencies (highlighted in yellow) referred to how engineers create digital processes to understand a phenomenon of interest (similar to John Boyd’s OODA loop: Observe, Orient, Decide, and Act). Additional competencies were identified for each level and are listed on the right and left of the main blocks in figure 9. Depending on the role, an employee would require certain competencies; however, no role will require all competencies.

---

4 This framework was based on preliminary results of research as of March 2020.
The four competency areas of Data Engineering, Modelling, Decision Making, and Engineering Methods are essential to digital artifacts lifecycle. Each of these areas was based on five competency types:

- **Manage/Lead**: Skills include understanding of the overall context including strategic long-term and tactical short-term technological support.
- **Architect**: Transforming objectives to systems and structures for long-term support.
- **Develop**: Designing, implementing, and providing necessary validation and verification.
- **Support**: Creating and supporting the digital environment, tools, and libraries to provide the maximum value.
- **Use**: Use the tools and artifacts to provide maximum value.
5. Building Digital Capabilities

This framework, developed by Jisc, speaks to six elements of ICT (see Figure 10):

- Functional skills: ICT proficiency and productivity
- Critical use: Information, data, media literacy
- Creative production: Digital creation, digital research, and problem solving, digital innovation
- Participation: digital communication, digital collaboration, digital participation
- Development: digital learning, digital teaching
- Self-actualising: digital identity management, digital well-being

This framework was developed with the purpose of being a starter to a larger conversation about organization goals and individual’s development plan. This framework can be used as a map of development opportunities and digital activities for staff and students to obtain a digital experience across various categories. Each category can be also used as a prompt card with ideas for digital activities.

CONCLUSION

A review of literature in relation to Identifying the Digital Skills Gap Between New Graduates from Engineering and Computer Science and Industry Expectations has revealed many interesting points that would benefit from further discussion between post-secondary institutes and industry leaders.

Various drivers and megatrends are affecting the digital skills gap in the workforce and need to be considered when attempting to close the gap. Artificial intelligence, digitalization, automation, and climate change, lead the list of trends. Driven by these trends and the unprecedented pace

---

5 Jisc is a non-for-profit education and skills organization for digital skills and services in the United Kingdom.
of change in digital technology advancement, companies will be looking for employees who are quick learners, effective communicators, and agile critical thinkers while being fluent in technology.

Employees who have technological knowledge and professional skills are commonly referred to as hybrid or T-shaped professionals. As technological advances become more embedded in every aspect of day-to-day lives, there will be a greater emphasis on the importance of understanding digital technology. Thus, the demand for t-shaped employees is expected to increase.

While there is currently no general agreement between different competency and literacy frameworks, there is an increasing acceptance of the need to focus on hard and soft/professional skills. Hard and soft skills are no longer considered as two distinct groups but are integrated at every level of development.

The Building Capacity Through Competency Development Project will use this literature review as a basis for exploring the digital skills gap and competency framework with industry partners through survey and focus group activities and creating capacity for co-operative learning opportunities.

This Project endeavors to explore how post-secondary institutions and industry can collaborate; to close the gap so new graduates are better prepared to meet industry needs; to help industry better identify their needs; to support employees in remaining relevant and to encourage the development of diverse T-shaped workforce.
APPENDIX A

List of Engineering-related and Higher Education-related Sources

Engineering-related
American Society of Civil Engineers
Canadian Journal of Civil Engineering
Engineers Canada (Some key engineering trends for the coming trade)
Information and Technology Council (Digital Talent: Road to 2020 and beyond (2016))
Journal of Industrial Engineering and Management
Skills and Competencies for Digital Transformation
The American Society of Mechanical Engineers
The Institution of Engineering and Technology

Higher Ed-related
Academica
BC Ministry of Advanced Education and Skills Training
Brookfield Institute
Conference Board of Canada
Education Advisory Board
Education Dive
EDUCAUSE (non-profit that helps HE elevate the impact of IT)
Eduvation (Ken Steele)
Employment and Social Development Canada
Future Skills Centre
Government of British Columbia
Government of Canada
Hanover Research
Higher Education Strategy Associates
Inside Higher Ed
Institute for the Future
JISC (UK)
McKinsey & Company
National Academy of Engineering (US)
OECD
University Affairs
Key Search Terms
Automation
Competency
Computer science
Digital competency
Digital fluency
Digital intelligence
Digital literacy/digitally-literate
Digital skills
Digital transformation
Digitalization
Digitization
 Employability skills and competencies
Engineering
Engineering
Engineering Education 4.0
Engineering higher education
Future of work
Immersive technology
Industries perception
Post-secondary institutions
University
APPENDIX C

**Equity and Skills Gap**

**Gender**


**Age**


**Indigenous Peoples**


**Women, Youth, Immigrants, Persons with disabilities, Indigenous peoples, displaced and mature workers.**


**Indigenous, female, youth, racialized minority are disproportionately represented in top five high risk, low mobility occupations in Canada.**


**Diversity, Women in Sciences**


**Immigrants, Women, Youth**


**The engineering gender gap**

APPENDIX D

Canada’s Growth Currency: Digital Talent Outlook 2023. The Information and Communications Technology Council

UX/UI Designer

**TOP 10 CRITICAL HARD SKILLS**

- Proficiency with JavaScript
- Proficiency with HTML
- Ability to work with and create APIs
- Expert use of InDesign
- Ability to work with open-source front-end web frameworks like AngularJS
- Expert use of design toolkits like Sketch
- Expert use of Photoshop
- Proficiency with open-source version control platforms like Git
- Familiarity with JavaScript libraries like jQuery
- Familiarity with product design platforms like InVision

Data Scientist

**TOP 10 CRITICAL HARD SKILLS**

- Proficiency with Python
- Proficiency with JavaScript
- Proficiency with SQL
- Expert use of Excel
- Strong understanding of Machine Learning
- Familiarity with open-source data libraries like TensorFlow
- Familiarity with data visualization programs like Tableau
- Familiarity with SAS
- Ability to use and manage cloud platforms like AWS
- Strong knowledge of AI for data science

DevOps Engineer

**TOP 10 CRITICAL HARD SKILLS**

- Extensive experience with continuous integration
- Proficiency with Java
- Proficiency with SQL
- Ability to use cloud platforms like AWS
- Proficiency with container management tools like Docker
- Proficiency with open-source automation software like Jenkins
- Ability to work with and create APIs
- Proficiency with open-source container orchestration systems like Kubernetes
- Familiarity with open-source deployment tools like Ansible
- Proficiency with automation products for software infrastructure like Puppet

Machine Learning Engineer

**TOP 10 CRITICAL HARD SKILLS**

- Proficiency with Python
- Deep knowledge of Machine Learning
- Proficiency with C/C++
- Proficiency with SQL
- Proficiency with Java
- Familiarity with open-source neural-network libraries like Keras
- Proficiency with open-source data libraries like TensorFlow
- Ability to use and manage cloud platforms like AWS
- Familiarity with open-source software utilities for networks like Hadoop
- Deep knowledge of natural language processing

Database Administrators

**TOP 10 CRITICAL HARD SKILLS**

- Proficiency with SQL
- Proficiency with database management systems like SQL Server
- Proficiency with database management software like Oracle
- Familiarity with open-source relational database management systems like MySQL
- Familiarity with data migration processes performed by SSIS
- Proficiency with report-generating software like SSRS
- Familiarity with cloud computing and virtualization software like VMware
- Proficiency with CRM tools like Microsoft Dynamics
- Ability to use cloud platforms like AWS
- Ability to use cloud platforms like Azure

IT Support Specialist

**TOP 10 CRITICAL HARD SKILLS**

- Expert use of Excel
- Proficiency with SQL
- Proficiency with ITIL practices
- Deep knowledge of local area networks (LAN)
- Familiarity with cloud computing and virtualization software like VMware
- Deep knowledge of virtual private networks (VPN)
- Familiarity with DNS
- Familiarity with programming languages like Java
- Familiarity with protocols used on IP networks like DHCP
- Proficiency with SharePoint
The high-demand occupations among cleantech businesses were chemical engineer and mechanical engineer.

<table>
<thead>
<tr>
<th>Chemical Engineer</th>
<th>Mechanical Engineer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TOP 5 CRITICAL HARD SKILLS</strong></td>
<td><strong>TOP 5 CRITICAL HARD SKILLS</strong></td>
</tr>
<tr>
<td>• Proficiency with building process flow diagrams (PFDs)</td>
<td>• Proficiency with design and drafting software like AutoCAD</td>
</tr>
<tr>
<td>• Proficiency with simulation software for chemical reaction models like AspenPlus</td>
<td>• Proficiency with modeling/engineering-based design software like SolidWorks</td>
</tr>
<tr>
<td>• Knowledge of good manufacturing practices (GMP)</td>
<td>• Familiarity with building modeling software like Revit</td>
</tr>
<tr>
<td>• Knowledge of relevant engineering standards administered by organizations like the ASME</td>
<td>• Proficiency with C++</td>
</tr>
<tr>
<td>• Familiarity with programmable logic controllers (PLC)</td>
<td>• Familiarity with human-machine interfaces (HMI) and dashboards</td>
</tr>
</tbody>
</table>

The high-demand occupations among clean resources businesses were process engineer and embedded software engineer.

<table>
<thead>
<tr>
<th>Process Engineer</th>
<th>Embedded Software Engineer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TOP 5 CRITICAL HARD SKILLS</strong></td>
<td><strong>TOP 5 CRITICAL HARD SKILLS</strong></td>
</tr>
<tr>
<td>• Proficiency with Python</td>
<td>• Proficiency with C/C++</td>
</tr>
<tr>
<td>• Proficiency with CAD</td>
<td>• Proficiency with Python</td>
</tr>
<tr>
<td>• Proficiency with SQL</td>
<td>• Possession of relevant software and hardware engineering designations like ARM</td>
</tr>
<tr>
<td>• Proficiency with modeling/engineering-based design software like SolidWorks</td>
<td>• Familiarity with communication interfaces for embedded systems like Serial Peripheral Interface (SPI)</td>
</tr>
<tr>
<td>• Familiarity with open-source operating systems like Linux</td>
<td>• Familiarity with TI Embedded software products</td>
</tr>
</tbody>
</table>

The high-demand occupations in advanced manufacturing were production technician and control engineer.

<table>
<thead>
<tr>
<th>Production Technician</th>
<th>Control Engineer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TOP 5 CRITICAL HARD SKILLS</strong></td>
<td><strong>TOP 5 CRITICAL HARD SKILLS</strong></td>
</tr>
<tr>
<td>• Knowledge of good manufacturing practices (GMP)</td>
<td>• Proficiency with design and drafting software like AutoCAD</td>
</tr>
<tr>
<td>• Familiarity with standard operating procedure (SOP) for manufacturing</td>
<td>• Proficiency with Java</td>
</tr>
<tr>
<td>• Familiarity with hazard analysis and critical control points (HACCP)</td>
<td>• Familiarity with programmable logic controllers (PLC)</td>
</tr>
<tr>
<td>• Proficiency with CAD</td>
<td>• Ability to work with and create APIs</td>
</tr>
<tr>
<td>• Expert use of Excel</td>
<td>• Familiarity with open-source operating systems like Linux</td>
</tr>
</tbody>
</table>
Additional examples of Competency Frameworks

1. **DigComp 2.0. European Commission**

The DigComp framework featured five competency areas which contained several specific competencies, proficiency levels, the knowledge, skills, and attitudes associated with each competency.

Digital Competence Framework for Citizens (DigComp): Competence Areas:

1. Information and data literacy
   1.1. Browsing, searching, and filtering data, information, and digital content
   1.2. Evaluating data, information, and digital content
   1.3. Managing data, information, and digital content
2. Communication and collaboration: interacting through digital technologies
   2.1. Sharing through digital technologies
   2.2. Engaging in citizenship through digital technologies
   2.3. Collaborating through digital technologies
   2.4. Netiquette
   2.5. Managing digital identity
3. Digital content creation
   3.1. Developing digital content
   3.2. Integrating and re-elaborating digital content
   3.3. Copyright and licenses
   3.4. Programming
4. Safety
   4.1. Protecting devices
   4.2. Protecting personal data and privacy
   4.3. Protecting health and well-being
   4.4. Protecting the environment
5. Problem solving
   5.1. Solving technical problems
   5.2. Identifying needs and technological responses
   5.3. Creatively using digital technologies
   5.4. Identifying digital competency gaps
2. Developing Canada's Digital-Ready Public Service: Attracting and Retaining a Highly Skilled, Diverse Workforce to Support the Government of Canada’s Digital Strategy. Diversity Institute, Ryerson University

Professional skills are no longer considered an add-on to the technical skills. Critical thinking and communication abilities are considered to be at the core of the ability to understand user needs, functional requirements, and expectations, and to match technological solutions to the clients’ needs. In order to develop literacies to remain relevant in the labour market, graduates need to build upon their credentials, continue learning in their workplaces, and embrace the concept of lifelong learning (see Figure 11). Taxonomies for digital skills are changing as fast as the technology around us. As AI becomes excels at certain aspects of job (e.g., coding), technical literacy and intelligence based on the ability to understand the user needs, functional requirements and expectations will become more important.

Figure 11 Source: Cukier, Dr. W. (2019). Developing Canada’s Digital-Ready Public Service: Attracting and Retaining a Highly Skilled, Diverse Workforce to Support the Government of Canada’s Digital Strategy. Diversity Institute, Ryerson University.

3. Engineering Education 4.0 Competence Development Framework

To prepare for the Engineering Education 4.0, the authors of this framework suggested that engineering curriculum needed to be based on a model that included emerging technologies competency:
“This competence includes micro-tasking, workflows, and ecosystem. Micro-tasking refers to the independence of emerging technology in work or the need for human intervention. Workflows refer to the complete acquisition of workflow and data flow by the emerging technology. Ecosystems refer to the combination of the cognitive processing of the data and machine-based computing to come up with compatible model which combines learning environment, work environment, competence profile, and personal competence.”

Figure 12 SerdarAsan, Ş. (2020). *Engineering Education Trends in the Digital Era*. IGI Global.

4. Digital Literacy Skills in the ‘Fake News’ Era. Digital Literacy Unpacked. This framework suggested that students needed to develop several critical skills to support digital transformations (see Figure 13). In addition to the skills, authors introduced several applications and impacts for each skill.
This framework suggested that innovative engineers should have the following characteristics:

- **Adapter** (energetic, active to learn, do and remake, positively accepting the opinion of others).
- **Multiple alternatives seeker** (capable of looking for a better way to execute a process, design or manufacture a product).
- **Experimenter** (capable of accepting uncertainty, using the creation of prototypes to evaluate the options).
• Knowledge integrator (capable of integrating one’s own knowledge with that of the team and technician to build new solutions).
• Deep Knowledge (educated professional with knowledge of a wide range of topics).
• Curious about doing and learning (reflective professional, constantly looking for new ideas and solutions).
• Communicator (able to effectively communicate ideas and persuade others).
• Responsible (able to take control of his or her activities and oversee a project from start to finish, responding to results and accepting possible mistakes).
• Persistent (committed, determined, resilient. He/she is convinced that he/she will achieve his/her objectives).
• Passionate (professional who is passionate about his/her work and the objectives he/she has achieved, transmitting his/her passion to his/her team).
• Collaborative and integrative (able to collaborate with others with specific knowledge and skills, to successfully achieve an innovation).
• Creative (able to generate new ideas or associations between ideas to produce original solutions).
• Risk-taker (willing to take risks and fail).
• Visionary (professional with a clear vision and objectives).
• Challenging (willing to do things differently, questioning traditional methods).
• Team leader and manager (professional who is a team leader and manager, facilitating and driving innovation).
• Implementer (who efficiently organizes and manages resources to develop an innovation).
• Analytical (meticulous, examining carefully).
• Business savvy (who knows the role of finance, sales, supply chains and the innovation market).
• User-focused (who seeks solutions focused on user needs).
Sources


42 Heubl, B. (2019, July 30). Analysis sniffs out engineering jobs with the most potential. https://eandt.theiet.org/content/articles/2019/07/analysis-on-engineering-skills/


Falzani, D. (2014, December 1). Give entrepreneurial skills to engineers for better innovation. The Engineer. https://www.theengineer.co.uk/give-entrepreneurial-skills-to-engineers-for-better-innovation/


Engineering ethics under the spotlight of new consultation. (2019, July 26). The Engineer. https://www.theengineer.co.uk/engineering-ethics-leeds-university/


