Examining Leadership within the Unique Context of Engineering Consulting

Ms. Jessica J. Li, P.E., University of Toronto, Canada

Jessica is a Professional Engineer currently pursuing her PhD in Mechanical and Industrial Engineering with the Troost Institute for Leadership Education in Engineering at the University of Toronto. Jessica's research explores how professional services organizations can support or hinder leadership development in their staff.

Jessica holds a Bachelor's of Applied Science in Chemical Engineering from the University of Toronto and previously worked as an engineering consultant in the biotech and pharmaceutical industries for eight years. Jessica's experience leading multidisciplinary teams strengthened her perspective that the ability to empathize, communicate and collaborate is integral to success in engineering.

Dr. Andrea Chan, University of Toronto, Canada

Andrea Chan is a Research Associate at the Troost Institute for Leadership Education in Engineering | University of Toronto

Catherine MacKenzie Campbell

MacKenzie Campbell is a MASc student in Chemical Engineering specializing in Engineering Education. Her thesis is exploring how the quality of work-integrated learning experiences shape women engineers' career intentions, with a focus on intersectionality and diverse engineering fields including emerging and non-traditional areas of practice. MacKenzie has an undergraduate engineering degree in Biomedical Systems Engineering, where her research focused on high-intensity focused ultrasound.

Elham Marzi, University of Toronto, Canada

Prof. Marzi is the Co-founder and Director of InVEST and has engaged in multidisciplinary research in Organizational Behaviour, Virtual Teams, and Engineering Education. She teaches in areas inclusive of OB, HR, Strategy, Virtual Teams, and Negotiations in the Engineering Business Minor and Certificate Program at the University of Toronto, Canada. She has a passion for teaching and getting students engaged through active and technology enhanced learning. She is highly interested in developing innovative teaching techniques and strategies that can contribute to students learning and increase equity and inclusivity in the classroom.

Dr. Emily Moore, P.E., University of Toronto, Canada

Emily Moore is the Director of the Troost Institute for Leadership Education in Engineering (Troost ILead) at the University of Toronto. Emily spent 20 years as a professional engineer, first as an R&D engineer in a Fortune 500 company, and then leading

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Introduction:

The development of leadership and professional skills is increasingly recognized as being an important aspect of the engineering profession. Accreditation boards across North America have called for engineering educators to equip engineering graduates with leadership capabilities to allow engineers to take on a more prominent role in technological, societal and business advancement [1], [2]. As a result, there has been increased focus and research around engineering leadership, both in terms of defining what it is (for example, [3], [4]), as well as identifying the associated skills and effective pedagogical practices for teaching it [5]–[7]. Engineering educators are working on closing the gap between the leadership needs of industry and the capability of engineering graduates. However, for particular sectors such as engineering consulting, given its unique client-focused nature and flat organizational structure [8], [9], leadership knowledge and skills may be particularly essential and distinctive, requiring study in its own specific context.

In this conceptual paper, we draw upon the literature of engineering leadership education, engineering leadership practice, and leadership in professional services firms (PSF), all of which are relevant to engineering consulting. As a part of our review, we discuss the convergence and divergence of the ways engineering leadership is discussed in these distinct but related bodies of literature and identify areas for further empirical research. Our synthesis will substantiate an argument for the need for empirical research on engineering leadership specific to the engineering consulting context.

Engineering consulting has become an increasingly important sector for engineering graduates. In 2015, technical and engineering consulting services were projected to be the 6th fastest growing global industry for the period of 2014-2024 [10]. This follows a global trend in rapid growth of consulting in general, fueled by globalization, the externalization of work from downsizing of internal resources, and the intensification of knowledge-work [8], [11], [12]. Today, globally, the engineering services market is a 1.6 trillion US dollar industry [13]. In the United States, engineering services alone generate an annual revenue of 360 billion US dollars and employ approximately 1.3 million people [14]. In Canada, approximately 200,000 individuals are employed in this sector, and the 36 billion Canadian dollar industry has more than doubled in size since 2006 [15], [16].

Beyond its steady growth as a sector, engineering consulting is an industry where leadership skills are a valued and integral part of the work. Engineering consultants communicate with clients and other stakeholders frequently, primarily work in teams, and collaborate closely with clients in the development of custom solutions [17]–[22]. Engineers in these firms can also move swiftly from one engagement to another, where the team, client, and technical nature of the job may be different depending on the specific requirements of the project [19]. According to Hining et al.,

> *PSF typically generate intangible experiential services in the form of knowledge-rich, time-sensitive advice that is tailored to a specific client's needs… this*

implies a much higher degree of "relationship embeddedness" and context sensitivity compared to many other kinds of business activities [9].

In other words, the more dynamic nature of engineering consulting firms and higher degree of independence and autonomy experienced by engineers in this type of work [18], [20] presents interpersonal and leadership challenges that may not be present in or may differ from traditional manufacturing firms, which often serve as a context for existing empirical research [22], [23].

Despite the increase in engineers employed in engineering consulting in the last decade and the importance of leadership skills in engineering consulting, there is limited scholarship that examines leadership and its development in this specific sector. The authors believe that not only is it beneficial for engineering educators to understand the leadership needs of this growing sector of work, but also that engineering consulting provides a rich context for understanding how leadership is enacted in engineering practice. As work becomes increasingly knowledge-intensive, leadership has become less associated with efficiency, tasks, and management of labor under the industrial paradigm; instead, leadership is increasingly relational and complex. Examining how leadership is enacted in engineering consulting, which operates in a highly fluid and negotiated context, can help us build our understanding of engineering leadership in this knowledge-intensive, post-industrial world.

Engineering Leadership in Engineering Education and Engineering Practice

Defining Engineering Leadership

Engineering educators have responded to the calls for the development of leadership and professional skills in engineering graduates, in part, by attempting to define engineering leadership and create programs for development of these skills [24]. Some scholars have applied traditional management theories of leadership to the engineering context, such as transformational leadership [25], or servant leadership [26]. However, Rottmann et al. found that some engineers resist the traditional notion of leadership, being uncomfortable with the 'imprecise, impractical, elitist and just "not us"' representation of leadership that is often hierarchical and in opposition to their service-oriented professional identities [27].

A leadership identity that resonates with engineers is one motivation for engineering leadership scholars to establish a profession-specific definition of *engineering leadership*. Scholars have also sought to find an engineering leadership definition that acknowledges the social, community, and societal impact of engineers, which is more difficult when applying theories from the field of management where the application or impact of technical expertise is not often discussed in leadership, beyond task efficiency or effectiveness. While there is no consensus on one singular definition of engineering leadership, scholars have worked towards definitions that converge on some common elements [4], [7], [28]:

- Engineering leadership is a process.
- Engineering leadership is not positional.
- Engineering leadership is relational and requires collaboration and influence of others.

Classifications in engineering leadership: traits, skills, qualities, themes, etc.
Similar to the abundance of leadership theories in management research, engineering leadership research has previously looked at traits, skills and styles to describe engineering leaders. Some of the literature on engineering leadership traits tended to focus on how engineers have unique attributes that differ from their non-engineering colleagues [29]–[32], thus establishing a basis for unique leadership needs, styles or outcomes. Personality differences in engineers have also been used to differentiate management styles. For example, Brown et al. [29] administered the California Psychological Inventory (CPI) personality test on engineers, engineering managers and non-engineering managers. The difference between their scores on the "psychological mindedness" scale led the authors to posit that engineering managers use a management style that has a greater reliance on intellectual insight and motivation of others, and less on pleasure derived from interpersonal interactions. Meanwhile, Riley [31] found that engineering managers engage more in behaviors that seek to win and minimize negative feelings, as opposed to seeking information to make an informed decision on who wins or loses. As well, Wyrick [32] identified that a decade of engineering student cohorts were "convergers" when it comes to their learning style, as defined by Kolb's Experiential Cycle of Learning. Convergers tend to prefer abstract conceptualization and active experimentation; based on engineering students' exhibited learning preferences, Wyrick makes recommendations on how engineers can be more effective managers, such as not jumping on the first answer and having diversity of learning styles to leverage strength of other learning preferences.

Alternatively, rather than working to define *who* engineering leaders are, a large body of engineering leadership research first assumes that leadership can be taught and therefore aims to identify qualities, skills and styles in order to guide curricular and co-curricular programming. The framework by Farr et al. [33] contains both trait-like attributes such as "big thinker", "ethical and courageous" and practiced skills and behaviors, such as "uses power wisely and good communicator." Their proposed leadership *qualities* framework is intended to support assessment and development of engineers' leadership abilities. While the classification of leadership (for example, skills, competencies, qualities, attributes, themes etc.) varies between and even within works, what is valued in engineering leadership converges on a few common attributes. Handley et al's [6] review found that studies of engineering leadership named as few as five competencies to as many as 27 attributes. Of the included literature, communication was the only skill cited by all, while the next more frequently noted attributes were collaboration and teamwork, vision and direction, interpersonal skills, and motivation. Hartmann and Jahren's [34] empirical work on early-career engineers found almost the same leadership themes, with initiative/ confidence as the one unique addition. A follow-up study by Hartmann et al. surveyed recruiters from various educational institutes and found initiative / confidence and communication were ranked to be the most important of the various skills and qualities that came up [35]. Lappalainen takes a higher level line of analysis and concludes emotional intelligence is more associated with leadership by subordinates compared to intelligence or personality, therefore calling for more intrapersonal and interpersonal professional development to benefit future managerial success [36]. Alternatively, some engineering educators have focused on how to best prepare students by investigating leadership developmental frameworks or pedagogical practices [37], [38], assessment tools of leadership capabilities of engineering students [39] and students' perceived confidence or competence in these skills [40], [41].

Studies of Engineering Leadership in Context

Engineering educators have examined the industry needs and gaps pertaining to leadership [5], [7], [36], [36], [42]–[46]. However, discussions around leadership requirements in engineering practice (whether considering leadership qualities, styles, or traits) tend not to emphasize the differences between organizations or industry sectors. For example, Fromel et al. [46] identified most frequent leadership behaviors in the workplace based on the experience of eight participants who came from a diverse set of disciplines and professional roles. To conceptualize leadership in the professional context, Rottmann and her colleagues examined the lived experience of senior engineering leaders and established three engineering leadership orientations: technical mastery, organizational innovation and collaborative optimization [27]. The three orientations discuss the ways that engineers lead, influence and benefit the team and organization around them. Yet, the three leadership orientations are not differentiated by the type of organization; organizations participating in the study represented a wide range of sectors (chemical, civil consulting, software, mining and metal processing). Although engineering leadership was examined in context across these studies, they did not consider in-depth the way that context may be a primary factor on how leadership could be carried out.

Differentiation of the context to examine engineering leadership is often around engineering **discipline**, for example, the review by Handley and colleagues is about civil engineering [6] (the authors call upon scholars to examine other disciplines with their framework), and **career stage,** such as [34], [35], [42], [47], [48], where engineering educators are concerned with equipping graduates with the skills they need for their first jobs after graduation. While the industrial context is described in the leadership studies involving engineering professional practice, there is limited discussion on *how* leadership behavior is influenced by the *particular* organizational setting. Factors such as size, organizational structure, and technology are likely to influence how leadership is enacted. Leadership scholars in management have called for this type of distinction in empirical research. Melcher in 1977 summarizes this perspective:

> *If the effects of varying leadership styles are to be unraveled, the research design will need either to hold organizational variables constant and explore for leadership effects, or to explore the interaction effects by incorporating organizational variables and leadership dimensions...*[49].

More recent leadership scholars have advocated for leadership studies that distinguish between variables impacting findings in leadership including the organizational context [50]–[52]

Engineering consulting organizations serve as a backdrop to some existing engineering leadership studies [42], [53]–[55], but these studies do not examine engineering consulting under the premise that this is a unique type of organizational context; instead, engineering consulting organizations happen to be the location for the research, rather than a factor of influence. Other texts focused on leadership in engineering consulting organizations are written for a non-academic, practitioner-oriented audience, advising executives on various facets of managing a firm based on experiences of professionals in the field, [55]–[59] rather than empirical research.

In the next section, we review the literature on Professional Services Firms (PSF), which considers the organization model as a variable that can impact the way that leadership is enacted. It is worthwhile to look at the existing body of literature on leadership and PSFs to prepare for an examination of engineering consulting leadership in a contextually specific way.

Understanding Engineering Consulting as a Professional Services Firm (PSF)

Defining PSFs

Engineering consulting organizations embody the distinct characteristics described by organizational researchers as Professional Services Firms (PSF). The growing body of literature on PSFs is relatively recent, as research related to leadership in PSFs has mostly emerged in the last three decades. However, research on professionals and professionalism, from where PSF research grew, started at the beginning of the twentieth century. Sociologists were interested in the autonomy and social status associated with professionals that were seen as an exception to the realities of hierarchical bureaucracies [60]. Other differentiating characteristics of professions included subject matter expertise, abiding by a set of ethical codes and autonomy over members' education, licensing and disciplining process [61]–[63]. However, by the 1960s, professionals were employed in large numbers inside organizations (for example, law, accounting, and state bureaucracies like hospitals) [64], [65]. PSF (professional services *firms)* research emerged in 1990s when organizational researchers were interested in managerial aspects within these firms, in particular, low and contingent managerial control, which were believed to be influenced by the distinct characteristics of these firms [22], [66], [67]. The focus of PSF research has primarily remained on law and accounting firms but has broadened to include management consulting firms and other types of knowledge-intensive firms.

Presently, the boundaries of what is a PSF remain up for debate, further made complex by the similarities between PSF and knowledge-intensive firms [68], [69]. However, there are agreed-upon distinct characteristics of PSFs which not only differ from traditional hierarchical firms [8], [9], [22], [70], but also have important implications for leadership [8], [22], [71], [72]. For this discussion, we borrow the framework established by Hinings et al. [9] which notes the following key distinct characteristics of PSFs:

- **Application of specialist knowledge** for *custom* solution or service for clients. The main organizational asset is the technical knowledge professionals have about the subject matter *and* their client [8], [9]. The emphasis of tailored solution and close interactions between consultant and client is what differentiates PSFs from other knowledge intensive firms like software development or equipment manufacturing.
- **Organizational structure** that affords *high autonomy* and *low or contingent managerial control* to their workforce [8], [9], [73], [74]. PSFs are regarded as "flat" organizations with fewer formal hierarchical roles of leadership.
- The core workforce of a PSF recognize each other and are recognized by clients and competitors as professionals. Their **professional identity** is shaped in part by the organization, alongside their training and professional licensure process [9], [75]. Their identity has implications for how they do their work, interact with their peers and assume leadership roles.

Leadership in Professional Service Firms

The high levels of autonomy and lack of command-control hierarchies inside PSFs render the typical dyadic leader-follower leadership theories less applicable and relevant in this organizational context [71], [72], [76]. Leadership research in the unique PSF context is relatively less developed compared to other areas of PSF research (for example, knowledge transfer, governance) [9], [67], [68], [71], [77], [78]. PSF literature has discussed leadership in other terms (e.g., strategic management, decision-making, entrepreneurship [12], [79]), where the distinction between management and leadership is sometimes ambiguous [22]. However, these existing bodies of work in PSF that are related to leadership converge on the concept of influence, and the ways influence is applied when there is a lack of direct authority.

Empson and Langely [71] developed a framework for understanding leadership in PSFs by reviewing practitioner-oriented texts (written for non-academic audience) and leadership theories developed in contexts that are closely relevant to PSF, such as studies of professions and knowledge-intensive organizations. Empson and Langely's conceptualization of leadership is based on three mechanisms for influence, where each mechanism draws upon a different resource of influence. The three mechanisms of influence are: professional expertise, political interaction, and personal embodiment. This framework borrows from Mintzberg's three key systems of influence: expertise, politics, and ideology [80].

- **Professional expertise** is a resource and mechanism for influence because PSFs are regarded as "meritocracies" [80]. Informal hierarchies exist based on technical expertise and professional authority [81], [82]. Professional expertise is closely linked to leadership due to the amount of influence that seniority and depth of expertise affords individuals, even when they are not necessarily in a place of positional power.
- **Political interaction** is a mechanism of influence that describes actions of lobbying and bargaining. This process of influence occurs through interpersonal relationships, where interactions have political and strategic objectives, and can occur without individuals recognizing it is happening. Alvesson and Svengingsson discuss simple actions as listening, chatting and "being cheerful" as a passive and intangible way of applying influence [83]–[85]. Mintzberg's also argues that "covert" leadership is more important than overt leadership [74]. Even without overt power, individuals can have significant influence by building consensus and forming allies for their objectives.
- The resource and mechanism of **personal embodiment** stems from individuals who embody the values and identity of the organization and exemplify the values and behaviours with which others within the PSF positively identify [86]. In this way, leaders shape the organizational identity and provides meaning for the professionals within the organization [75], [87].

For all three mechanisms, influence could be applied to different levels: individuals and teams, organizational, and strategic levels. Individuals with seniority and expertise influence individuals and teams through an apprenticeship-like model of training and socialization within PSFs [88]. Alternatively, interpersonal interactions between individuals are ways to apply influence for political means, by building trust and loyalty with another individual. At an organizational level, leaders employing political interaction can take both a passive approach, (for example, removing roadblocks for colleagues whose vision aligns with the goals for the firm [89]), or selectively intervening with more explicit actions, such as following a merger [90]. This form of political interaction requires leaders to have insight and keen understanding of the complexities of the organization and their peers. At the strategic level, entrepreneurs inside PSF can initiate a new service offering for the firm or find a new market for an existing service. To do so, they leverage their expertise of the clients and specialist knowledge to champion new initiatives.

Mapping Engineering Leadership in PSF Literature: Areas of Convergence and Divergence

Engineering consulting is a type of work that requires individuals to have strong leadership abilities to navigate the highly customized and technical work alongside unique organizational characteristics. We have examined two distinct but related bodies of literature on leadership to understand how leadership may be enacted in engineering consulting, but there presently is limited empirical research about leadership in consulting. Despite this, the following is a synthesis from our literature review, an organization of themes and the ways in which they are explored differently under engineering leadership and PSF leadership research.

Leadership defined by influence

Engineering practice and engineering education researchers have emphasized that leadership is about the ability to influence, and that this influence is not derived from positional power or authority [3], [4]. Conceptualizations of leadership in PSF literature is in strong agreement, due to the minimal and distributed nature of positional leadership within these organizations and the highly autonomous nature of professional work. Both sets of literature acknowledge the different levels of influence of a leader, spanning from the individual to the organizational level. In engineering leadership, there is a greater discussion of the community and societal impact from a professional's work and technology.

Leadership: *what* vs. *how*

Engineering leadership researchers have focused on classifying the traits, skills, or qualities in engineering leaders for them to be able to exert influence. There is a focus on naming and defining a collection of leadership qualities that will equip engineers to lead, distilling it down to teachable skills or attributes, with less specific discussion on how influence is exerted, who the influence is exerted upon, or the circumstances in which influence is applied. However, there have been efforts (e.g., see Rottmann et al. [27]) to examine leadership in a professionally contextual way where the focus on a leader's influence is noted. In PSF research, the focus on influence has been around *how* individuals exercise their influence at different levels within an organization. Researchers have noted that different professionals within the same organization may have different resources for influence; whether it is by applying professional expertise, through political interaction, or by personally embodying the firm's ideals, it is unlikely that one person will enact all these ways to influence. The PSF research has limited focus on how some professionals learn mechanisms of influence and become leaders within their organization. The lack of defined leadership roles within PSF, and the various ways that individuals can lead or influence, means that studying and defining leadership in this context can be complex and ambiguous. This may contribute to why PSF scholars have paid less attention to specific traits or skills of leaders in PSF, but rather the outcomes that result from their influence. This also underlines why traditional theories of management, which are often established in controlled, dyadic leader-follower, hierarchical organizations are less applicable in the decentralized power structure of PSFs.

Focus of leadership research

PSF research tends to examine senior leaders more closely and their impact at the firm and strategic level. Studies citing influence at the individual or team level are less emphasized in the literature, and leadership in terms of strategic management (after a merger or acquisition, for example [91], [92], or governance [67], [78]) is more studied. The organizational innovation Engineering Leadership Orientation found by Rottmann et al. speaks about influencing vision and goals at the organizational level [27], but most engineering leadership research tends to be more focused on the applying these skills to the self or the team, a smaller sphere of influence. As a result, engineering leadership findings to date may have more applicability to early-career engineers, and PSF leadership findings to professionals towards the later stages of their career.

The role of context in leadership research

Leadership in PSF research is defined and shaped by the organizational context as the distinguishing characteristics of PSF firms are linked to how leadership is enacted. On the other hand, previous examinations of leadership in engineering practice acknowledge the workplace context, but context is not necessarily considered an influential impact to how leadership is practiced. Currently, accounting and law firms are common grounds for PSF research. Thus, while leadership has been examined in an organizational contextual manner, engineering consulting could still differ from these fields. In particular, the teamwork-based and highly collaborative nature of engineering projects is dissimilar to how accounting and law is often practiced. While scholars have acknowledged the heterogeneity of PSF firms and the need to account for the breadth of PSFs in future empirical work [8], [18], [21], empirical research in engineering consulting will provide more nuanced understanding of how leadership is enacted. As well, more research in how leadership is learned and practiced for early-career engineering consultants will support engineering educators in teaching leadership skills in the classroom.

Implications for future research:

In 2021, the global engineering services industry grew by 10% [13], following trends of prior years. As more engineers join this sector of work, empirical research studying the nature of leadership skills and mechanisms for effective influence in engineering consulting organizations will further our understanding of engineering leadership in knowledge-intensive, relationally complex environments. Engineering educators benefit from this research by better understanding of how engineers learn to influence and lead in an environment where leadership roles are more ambiguous and distributed. As work in general moves toward hybrid, distributed environments, such as with a global, remote workforce, we may see traditional hierarchical leadership evolve into flatter, higher autonomy, PSF-like structures. As well, uncovering how organizations support learning and development of these leadership skills can translate to more effective pedagogical practices for engineering students. Lastly, empirical studies of leadership in engineering consulting also adds to the leadership literature in PSF research, where empirical work in the setting of engineering firms is limited. Research in this area can help build a more nuanced and inclusive definition of PSF, where engineering firms are currently underrepresented compared to law and accounting.

References:

[1] *The Engineer of 2020: Visions of Engineering in the New Century*. Washington, D.C.: National Academies Press, 2004, p. 10999. doi: 10.17226/10999.

[2] CEAB, “Accreditation Criteria and Procedures 2017.” Engineers Canada, 2017. Accessed: Feb. 11, 2023. [Online]. Available: https://engineerscanada.ca/sites/default/files/accreditation-criteria-procedures-2017.pdf

[3] M. R. Kendall, D. Chachra, K. Gipson, and K. Roach, “Motivating the need for an engineering-specific approach to student leadership development,” *New Directions for Student Leadership*, vol. 2022, no. 173, pp. 13–21, Mar. 2022, doi: 10.1002/yd.20475.

[4] R. Paul, A. Sen, and E. Wyatt, “What is Engineering Leadership? A Proposed Definition,” in *2018 ASEE Annual Conference & Exposition*, Salt Lake City, Utah, Jun. 2018. doi: 10.18260/1-2--30137.

[5] J. V. Farr and D. M. Brazil, “Leadership Skills Development for Engineers,” *Engineering Management Journal*, vol. 21, no. 1, pp. 3–8, Mar. 2009, doi: 10.1080/10429247.2009.11431792.

[6] M. Handley, J. Plumblee, and A. Erdman, “The Engineering Leader of the Future: Research and Perspectives,” in *2018 ASEE Annual Conference & Exposition Proceedings*, Salt Lake City, Utah: ASEE Conferences, Jun. 2018, p. 31096. doi: 10.18260/1-2--31096.

[7] R. Schuhmann, “Engineering Leadership Education: The Search for Definition and a Curricular Approach,” *Journal of STEM Education: Innovations and Research*, vol. 11, pp. 61–69, Jan. 2010.

[8] A. von Nordenflycht, “What Is a Professional Service Firm? toward a Theory and Taxonomy of Knowledge-Intensive Firms,” *The Academy of Management Review*, vol. 35, no. 1, pp. 155–174, 2010, Accessed: Aug. 28, 2022. [Online]. Available: http://www.jstor.org/stable/27760045

[9] B. Hinings, D. Muzio, J. Broschak, and L. Empson, “Researching Professional Service Firms: An Introduction and Overview,” in *The Oxford Handbook of Professional Service Firms*, First edition.Oxford, United Kingdom: Oxford University Press, 2015.

[10] R. Henderson, “Industry employment and output projections to 2024.” Monthly Labor Review, vol 138, 2015.

[11] L. Empson, D. Muzio, J. P. Broschak, and C. R. Hinings, Eds., *The Oxford handbook of professional service firms*, First edition. Oxford, United Kingdom: Oxford University Press, 2015.

[12] B. R. Løwendahl, *Strategic management of professional service firms*, 3. ed., 2. impr. Copenhagen: CBS Press, 2009.

[13] IBISWorld, “Global Industry Report L6722-GL Global Engineering Services - MyIBISWorld,” 2021. https://my.ibisworld.com/gl/en/industry/l6722-gl/key-statistics (accessed Mar. 13, 2023).

[14] IBISWorld, “Engineering Services in the US - Industry Data, Trends, Stats | IBISWorld,” 2022. https://www.ibisworld.com/united-states/market-research-reports/engineering-services-industry/ (accessed Feb. 12, 2023).

[15] “Engineering Services in Canada - Market Research Report,” *tIBISWorld - Industry Market Research, Reports, and Statistics*. https://www.ibisworld.com/default.aspx (accessed Mar. 12, 2023).

[16] "Status of the Canadian Consulting Engineering Industry - Canadian Consulting Engineer." https://www.canadianconsultingengineer.com/features/status-of-the-canadian-consulting-engineering-industry/ (accessed Mar. 12, 2023).
[17] N. Malhotra, "The Nature of Knowledge and the Entry Mode Decision," *Organization Studies*, vol. 24, no. 6, pp. 935–959, Jul. 2003, doi: 10.1177/0170840603024006006.
[18] N. Malhotra and T. Morris, "Heterogeneity in Professional Service Firms," *Journal of Management Studies*, vol. 46, no. 6, pp. 895–922, 2009, doi: 10.1111/j.1467-6486.2009.00826.x.
[19] S. Pantic-Dragisic and E. Borg, "Creating the mobile engineer: a study of a training program for engineering consultants," *EJTD*, vol. 42, no. 7/8, pp. 381–399, Oct. 2018, doi: 10.1108/EJTD-12-2017-0117.
[20] S. Pantic-Dragisic and J. Söderlund, "Swift transition and knowledge cycling: Key capabilities for successful technical and engineering consulting?," *Research Policy*, vol. 49, no. 1, p. 103880, Feb. 2020, doi: 10.1016/j.respol.2019.103880.
[21] A. von Nordenflycht, N. Malhotra, and T. Morris, *Sources of Homogeneity and Heterogeneity across Professional Services*, vol. 1. Oxford University Press, 2015. doi: 10.1093/oxfordhb/9780199682393.013.7.
[22] D. H. Maister, *Managing the professional service firm*, First Free Press paperbacks edition. in Free Press paperbacks. New York London Toronto Sydney Singapore: Free Press, 1997.
[23] D. J. Teece, "Expert talent and the design of (professional services) firms," *Industrial and Corporate Change*, vol. 12, no. 4, pp. 895–916, Aug. 2003, doi: 10.1093/icc/12.4.895.
[24] M. Klassen, D. Reeve, C. Rottmann, R. Sacks, A. Simpson, and A. Huynh, "Charting the Landscape of Engineering Leadership Education in North American Universities," in *2016 ASEE Annual Conference & Exposition Proceedings*, New Orleans, Louisiana: ASEE Conferences, Jun. 2016, p. 26486. doi: 10.18260/p.26486.
[25] P. J. Breaux, "An effective leadership approach for today's engineer 2006 IEEE/UT EMC," in *2006 IEEE/UT Engineering Management Conference*, Austin, TX, USA: IEEE, Aug. 2006, pp. 61–65. doi: 10.1109/UTEMC.2006.5236200.
[26] E. A. Croft, P. Winkelman, A. Boisvert, and K. Patten, "Global Engineering Leadership – Design and Implementation of Local and International Service Learning Curriculum for Senior Engineering Students," *PCEEA*, Jun. 2013, doi: 10.24908/pceea.v0i0.4868.
[27] C. Rottmann, R. Sacks, and D. Reeve, "Engineering leadership: Grounding leadership theory in engineers' professional identities," *Leadership*, vol. 11, no. 3, pp. 351–373, Aug. 2015, doi: 10.1177/1742715014543581.
[28] R. L. D. Komarek, "In search of a definition and frameworks for engineering leadership development," *New Directions for Student Leadership*, vol. 2022, no. 173, pp. 33–41, Mar. 2022, doi: 10.1002/yd.20477.
[29] J. S. Brown, C. W. Grant, and M. J. Patton, "A CPI comparison of engineers and managers," *Journal of Vocational Behavior*, vol. 18, no. 3, pp. 255–264, Jun. 1981, doi: 10.1016/0001-8791(81)90013-0.
[30] L. A. Mallette, "Theory Pi - engineering leadership not your theory X, Y or Z leaders," in *2005 IEEE Aerospace Conference*, Mar. 2005, pp. 4389–4397. doi: 10.1109/AERO.2005.1559744.
[31] T. Riley and E. A. Cudney, "Defensive Routines in Engineering Managers and Non-Engineering Managers — A Case Analysis," *International Journal of Engineering Business Management*, vol. 7, p. 8, Jan. 2015, doi: 10.5772/60114.

[32] D. A. Wyrick, "Understanding Learning Styles to be a More Effective Team Leader and Engineering Manager," *Engineering Management Journal*, vol. 15, no. 1, pp. 27–33, Mar. 2003, doi: 10.1080/10429247.2003.11415193.
[33] J. V. Farr, S. G. Walesh, and G. B. Forsythe, "Leadership Development for Engineering Managers," *J. Manage. Eng.*, vol. 13, no. 4, pp. 38–41, Jul. 1997, doi: 10.1061/(ASCE)0742-597X(1997)13:4(38).
[34] B. L. Hartmann and C. T. Jahren, "Leadership: Industry needs for entry-level engineering positions," *IEEE Eng. Manag. Rev.*, vol. 44, no. 3, pp. 76–85, 2015, doi: 10.1109/EMR.2016.7559063.
[35] B. L. Hartmann, C. M. Stephens, and C. T. Jahren, "Validating the Importance of Leadership Themes for Entry-Level Engineering Positions," *J. Prof. Issues Eng. Educ. Pract.*, vol. 143, no. 1, p. 04016016, Jan. 2017, doi: 10.1061/(ASCE)EI.1943-5541.0000301.
[36] P. Lappalainen, "Predictors of effective leadership in industry – should engineering education focus on traditional intelligence, personality, or emotional intelligence?," *European Journal of Engineering Education*, vol. 40, no. 2, pp. 222–233, Mar. 2015, doi: 10.1080/03043797.2014.944102.
[37] D. J. Bayless, "Developing Leadership Skills in Engineering Students – Foundational Approach through Enhancement of Self-Awareness and Interpersonal Communication," *PCEEA*, Jun. 2013, doi: 10.24908/pceea.v0i0.4818.
[38] M. Caeiro-Rodriguez *et al.*, "Teaching Soft Skills in Engineering Education: An European Perspective," *IEEE Access*, vol. 9, pp. 29222–29242, 2021, doi: 10.1109/ACCESS.2021.3059516.
[39] S. Özgen, O. Sánchez-Galofré, J. R. Alabart, M. Medir, and F. Giralt, "Assessment of Engineering Students' Leadership Competencies," *Leadership Manage. Eng.*, vol. 13, no. 2, pp. 65–75, Apr. 2013, doi: 10.1061/(ASCE)LM.1943-5630.0000168.
[40] R. Komarek, A. R. Bielefeldt, and D. W. Knight, "Influences of Engineering Students' College Experiences on Leadership Skill Assurance," *The International journal of engineering education*, vol. 37, no. 5, pp. 1454–1465, 2021.
[41] J. Magarian and A. Olechowski, "Engineering Students and Group Membership: Patterns of Variation in Leadership Confidence and Risk Orientation," in *2018 ASEE Annual Conference & Exposition Proceedings*, Salt Lake City, Utah: ASEE Conferences, Jun. 2018, p. 30417. doi: 10.18260/1-2--30417.
[42] S. Brunhaver, S. Gilmartin, M. Grau, S. Sheppard, and H. Chen, "Not All the Same: A Look at Early Career Engineers Employed in Different Sub-Occupations," in *2013 ASEE Annual Conference & Exposition Proceedings*, Atlanta, Georgia: ASEE Conferences, Jun. 2013, p. 23.930.1-23.930.27. doi: 10.18260/1-2--22315.
[43] W. Groeneveld, J. Vennekens, and K. Aerts, "Identifying Non-Technical Skill Gaps in Software Engineering Education: What Experts Expect But Students Don't Learn," *ACM Trans. Comput. Educ.*, vol. 22, no. 1, pp. 1–21, Mar. 2022, doi: 10.1145/3464431.
[44] P. Lappalainen, "Communication as part of the engineering skills set," *European Journal of Engineering Education*, vol. 34, no. 2, pp. 123–129, May 2009, doi: 10.1080/03043790902752038.
[45] V. Parts, M. Teichmann, and T. Rüütmann, "Would Engineers Need Non-technical Skills or Non-technical Competences or Both?," *Int. J. Eng. Ped.*, vol. 3, no. 2, p. 14, Mar. 2013, doi: 10.3991/ijep.v3i2.2405.

[46] M. Fromel, M. Bennett, L. Wei, M. Handley, D. Lang, and A. Erdman, “Engineering Leadership Styles Used in Industry Today,” in *2019 ASEE Annual Conference & Exposition Proceedings*, Tampa, Florida: ASEE Conferences, Jun. 2019, p. 32730. doi: 10.18260/1-2--32730.
[47] M. Handley and C. G. P. Berdanier, “Operationalizing interpersonal behaviours of leadership for early-career engineers,” *INT J ENG EDUC*, vol. 35, no. 3, pp. 719–732, 2019.
[48] B. Novoselich and D. Knight, “Developing Engineers Who Lead: Are Student, Faculty, and Administrator Perspectives Aligned?,” in *2014 ASEE Annual Conference & Exposition Proceedings*, Indianapolis, Indiana: ASEE Conferences, Jun. 2014, p. 24.401.1-24.401.17. doi: 10.18260/1-2--20292.
[49] A. J. Melcher, “Leadership models and research approaches,” in *Leadership: the cutting edge: a symposium held at Southern Illinois University, Carbondale, October 27-28, 1976*, J. G. Hunt, L. L. Larson, Southern Illinois University at Carbondale, and Southern Illinois University at Carbondale, Eds., Carbondale: Southern Illinois University Press, 1977.
[50] J. E. Dinh, R. G. Lord, W. L. Gardner, J. D. Meuser, R. C. Liden, and J. Hu, “Leadership theory and research in the new millennium: Current theoretical trends and changing perspectives,” *The Leadership Quarterly*, vol. 25, no. 1, pp. 36–62, Feb. 2014, doi: 10.1016/j.leaqua.2013.11.005.
[51] J. G. Hunt and G. E. Dodge, “Leadership déjà vu all over again,” *The Leadership Quarterly*, vol. 11, no. 4, pp. 435–458, Dec. 2000, doi: 10.1016/S1048-9843(00)00058-8.
[52] R. G. Lord and J. E. Dinh, “What Have We Learned That Is Critical in Understanding Leadership Perceptions and Leader-Performance Relations?,” *Ind. organ. psychol.*, vol. 7, no. 2, pp. 158–177, Jun. 2014, doi: 10.1111/iops.12127.
[53] F. A. Grootboom, Pretorius, J. H. C., and L. Pretorius, “A case study of leadership in consulting engineering,” in *2011 Proceedings of PICMET ’11: Technology Management in the Energy Smart World (PICMET)*, Aug. 2011, pp. 1–6.
[54] A. S. Chang and C. W. Ibbs, “Development of Consultant Performance Measures for Design Projects,” *Project Management Journal*, vol. 29, no. 2, pp. 39–54, Jun. 1998, doi: 10.1177/875697289802900207.
[55] T. Kenner and M. A. Isaak, “Effective Leadership Development in a Civil-Engineering Culture: Finding the Balance-Point between Experience and Experiment,” *Leadership Manage. Eng.*, vol. 4, no. 3, pp. 105–109, Jul. 2004, doi: 10.1061/(ASCE)1532-6748(2004)4:3(105).
[56] P. M. Hartley, *Consulting engineering: constructing the future*. Baldok, Hertfordshire, England ; Philadelphia, PA: Research Studies Press, 2000.
[57] T. G. Hicks and J. F. Mueller, *Standard handbook of consulting engineering practice: starting, staffing, expanding, and prospering in your own consulting business*, 2nd ed. New York: McGraw-Hill, 1996.
[58] T. Ellis, *Leading and managing professional services firms in the infrastructure sector*. London ; New York: Routledge, Taylor & Francis Group, 2018.
[59] D. J. Singleton, “Management and leadership of a consulting engineering enterprise,” *Australian Journal of Civil Engineering*, vol. 2, no. 1, pp. 55–61, Jan. 2005, doi: 10.1080/14488353.2005.11463915.

[60] A. Abbott, *The system of professions: An essay on the division of expert labor.* in The system of professions: An essay on the division of expert labor. Chicago, IL, US: The University of Chicago Press, 1988, pp. xvi, 435.
[61] A. M. (Alexander M. Carr-Saunders 1886-1966, *The Professions / by A.M. Carr-Saunders and P.A. Wilson*. Oxford: Clarendon Press, 1933.
[62] M. L. Cogan, "Toward a Definition of Profession," *HARVARD EDUC REV*, vol. 23, no. 1, pp. 33–50, 1953.
[63] W. J. Goode, "Community Within a Community: The Professions," *American Sociological Review*, vol. 22, no. 2, p. 194, Apr. 1957, doi: 10.2307/2088857.
[64] R. H. Hall, "Professionalization and Bureaucratization," *American Sociological Review*, vol. 33, no. 1, p. 92, Feb. 1968, doi: 10.2307/2092242.
[65] W. R. Scott, "Reactions to Supervision in a Heteronomous Professional Organization," *Administrative Science Quarterly*, vol. 10, no. 1, p. 65, Jun. 1965, doi: 10.2307/2391650.
[66] D. J. Cooper *et al.*, "Sedimentation and Transformation in Organizational Change: The Case of Canadian Law Firms," *Organization Studies*, vol. 17, no. 4, pp. 623–647, Jul. 1996, doi: 10.1177/017084069601700404.
[67] R. Greenwood, C. R. Hinings, and J. Brown, "'P2-Form' Strategic Management: Corporate Practices in Professional Partnerships," *The Academy of Management Journal*, vol. 33, no. 4, pp. 725–755, 1990, doi: 10.2307/256288.
[68] M. Alvesson, *Management of knowledge-intensive companies*. in De Gruyter studies in organization, no. 61. Berlin ; New York: Walter de Gruyter, 1995.
[69] G. Winch and E. Schneider, "MANAGING THE KNOWLEDGE-BASED ORGANIZATION: THE CASE OF ARCHITECTURAL PRACTICE," *J Management Studies*, vol. 30, no. 6, pp. 923–937, Nov. 1993, doi: 10.1111/j.1467-6486.1993.tb00472.x.
[70] R. Greenwood and R. Suddaby, Eds., *Professional service firms*, 1. ed. in Research in the sociology of organizations, no. 24.2006. Amsterdam Heidelberg: Elsevier JAI, 2006.
[71] L. Empson and A. Langley, "Leadership and Professionals," in *The Oxford handbook of professional service firms*, L. Empson, D. Muzio, J. Broschak, and B. Hinings, Eds., First edition.Oxford, United Kingdom: Oxford University Press, 2015. doi: 10.1093/oxfordhb/9780199682393.013.11.
[72] E. Fenton and A. Pettigrew, "Leading Change in the New Professional Service Firm: Characterizing Strategic Leadership in a Global Context," in *Research in the Sociology of Organizations*, Bingley: Emerald (MCB UP), 2006, pp. 101–137. doi: 10.1016/S0733-558X(06)24005-9.
[73] H. Mintzberg, *The Structuring of Organizations - Henry Mintzberg.* Prentice-Hall, 1979.
[74] H. Mintzberg, "Covert Leadership: Notes On Managing Professionals," *Harvard Business Review*, vol. 76, no. 6, pp. 140–147, Dec. 1998, [Online]. Available: https://search.ebscohost.com/login.aspx?direct=true&db=buh&AN=1248008&site=ehost-live
[75] M. Alvesson, D. Karreman, and K. Sullivan, "Professional Service Firms and Identity," in *The Oxford handbook of professional service firms*, L. Empson, D. Muzio, J. Broschak, and B. Hinings, Eds., First.Oxford, United Kingdom: Oxford University Press, 2015. doi: 10.1093/oxfordhb/9780199682393.013.18.
[76] P. S. Adler, S.-W. Kwon, and C. Heckscher, "Professional Work: The Emergence of Collaborative Community," *Organization Science*, vol. 19, no. 2, pp. 359–376, 2008, Accessed: Dec. 19, 2022. [Online]. Available: https://www.jstor.org/stable/25146184

[77] M. Alvesson, *Knowledge work and knowledge-intensive firms*. Oxford ; New York: Oxford University Press, 2004.
[78] R. Greenwood and L. Empson, “The Professional Partnership: Relic or Exemplary Form of Governance?,” *Organization Studies*, vol. 24, no. 6, pp. 909–933, Jul. 2003, doi: 10.1177/0170840603024006005.
[79] Strannegård, L., “Leadership in Entrepreneurial Professional Service Firms,” in *Handbook of Research on Entrepreneurship in Professional Services*, M. Reihlen, Ed., Cheltenham, UK: Edward Elgar, 2012, pp. 170–180.
[80] Henry Mintzberg, *Power in and Around Organizations*. Pearson College Division, 1983.
[81] A. D. Brown, M. Kornberger, S. R. Clegg, and C. Carter, “‘Invisible walls’ and ‘silent hierarchies’: A case study of power relations in an architecture firm,” *Human Relations*, vol. 63, no. 4, pp. 525–549, Apr. 2010, doi: 10.1177/0018726709339862.
[82] T. Diefenbach and J. A. A. Sillince, “Formal and Informal Hierarchy in Different Types of Organization,” *Organization Studies*, vol. 32, no. 11, pp. 1515–1537, Nov. 2011, doi: 10.1177/0170840611421254.
[83] M. Alvesson and S. Sveningsson, “The great disappearing act: difficulties in doing ‘leadership,’” *The Leadership Quarterly*, vol. 14, no. 3, pp. 359–381, Jun. 2003, doi: 10.1016/S1048-9843(03)00031-6.
[84] M. Alvesson and S. Sveningsson, “Good Visions, Bad Micro-management and Ugly Ambiguity: Contradictions of (Non-)Leadership in a Knowledge-Intensive Organization,” *Organization Studies*, vol. 24, no. 6, pp. 961–988, Jul. 2003, doi: 10.1177/0170840603024006007.
[85] M. Alvesson and S. Sveningsson, “Managers Doing Leadership: The Extra-Ordinarization of the Mundane,” *Human Relations*, vol. 56, no. 12, pp. 1435–1459, Dec. 2003, doi: 10.1177/00187267035612001.
[86] D. A. Gioia and K. Chittipeddi, “Sensemaking and Sensegiving in Strategic Change Initiation,” *Strategic Management Journal*, vol. 12, no. 6, p. 433, Sep. 1991, [Online]. Available: http://myaccess.library.utoronto.ca/login?qurl=https%3A%2F%2Fwww.proquest.com%2Fscholarly-journals%2Fsensemaking-sensegiving-strategic-change%2Fdocview%2F224967393%2Fse-2%3Faccountid%3D14771
[87] T. DeLong, J. J. Gabarro, and R. Lees, *When professionals have to lead: a new model for high performance*. Boston, Mass: Harvard Business School Press, 2007.
[88] F. Anderson-Gough, C. Grey, and K. Robson, “In the Name of the Client: The Service Ethic in Two Professional Services Firms,” *Human Relations*, vol. 53, no. 9, pp. 1151–1174, Sep. 2000, doi: 10.1177/0018726700539003.
[89] N. Anand, H. K. Gardner, and T. Morris, “Knowledge-Based Innovation: Emergence and Embedding of New Practice Areas in Management Consulting Firms,” *AMJ*, vol. 50, no. 2, pp. 406–428, Apr. 2007, doi: 10.5465/amj.2007.24634457.
[90] M. Uhl-Bien, R. Marion, and B. McKelvey, “Complexity Leadership Theory: Shifting Leadership from the Industrial Age to the Knowledge Era,” in Issues in Business Ethics. Dordrecht: Springer Netherlands, 2011, pp. 109–138. doi: 10.1007/978-90-481-9014-0_8.
[91] L. Empson, “Fear of Exploitation and Fear of Contamination: Impediments to Knowledge Transfer in Mergers between Professional Service Firms,” *Human Relations*, vol. 54, no. 7, pp. 839–862, Jul. 2001, doi: 10.1177/0018726701547003.

[92] R. Greenwood, C. R. Hinings, and J. Brown, “Merging Professional Service Firms,” *Organization Science*, vol. 5, no. 2, pp. 239–257, 1994, Accessed: Apr. 09, 2023. [Online]. Available: http://www.jstor.org/stable/2635017