Technological Stewardship: Assessing a Value-Sensitive Approach to "Engineering For Good"

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***Abstract*— This work-in-progress paper motivates and introduces a study of technological stewardship in Canadian engineering education. Technological stewardship is a concept advanced within the Canadian engineering community since 2017 by the Engineering Change Lab (ECL), and which is now the basis of the ECL's Tech Stewardship Practice program (TSPP). We propose viewing technological stewardship as a form of "engineering for good," i.e. as an approach to engineering that emphasizes doing good as a primary goal and outcome. Additional research is required to situate technological stewardship and the TSPP within the realm of engineering for good, to define and describe the approach to doing good that the program advances, and to understand how participants in the TSPP appreciate and implement technological stewardship in their lives and careers.**

Keywords—engineering for good, tech stewardship, engineering ethics, macro-ethics, technology and society

I. INTRODUCTION

Engineers and engineering educators have long reckoned with the need for engineering students to consider the ethical aspects of their work, including the relationship between engineering and the societies that it purports to serve [1-3]. Both the Canadian and American accreditation bodies for undergraduate engineering programs have required graduate attributes that address ethics, equity, and the "impact" of technology on society [4-5]. While all accredited engineering programs in Canada and the United States are bound by these criteria, and all practicing engineers must abide by codes of ethics, some engineering programs and organizations take a more direct and intentional approach to creating positive social, ethical, and environmental impact.

In recent decades, educators have augmented "micro" approaches to engineering ethics - which focus on specific ethical decision-making processes, and which have traditionally dominated Anglo-American engineering ethics instruction - with "macro" approaches that consider engineers' collective social responsibility [6-7]. 'Engineering for good' is an expansive term which describes a macro approach to engineering where engineers take doing good as their foremost priority, emphasizing doing good above other common engineering priorities such as technological efficiency, cost reduction, profit, and innovation [8].

Due to the broad nature of the 'engineering for good' concept, groups and initiatives that fall under this descriptor may have a wide range of interpretations of what "doing good" looks like in practice. Their motivations may be humanitarian, ecological, political, or religious, among other possibilities, and the intended outcomes of engineering for good are similarly diverse [8]. Indeed, as Kleine and Lucena describe, "engineers for good" is an analytical category: most practitioners favour terminology that relates more closely to their specific field or organization, e.g. "humanitarian engineering" or "engineering and social justice" [8]. One strength of 'engineering for good' as a tool for analysis lies in its description of the common roots of these disparate practices and organizations, which it locates in the late 20th and early 21st centuries, following the rise of sustainable development and amid calls for the globalization of engineering education. Another strength is the ability of the 'engineering for good' category to emphasize the many possible meanings and intentions behind 'doing good.' The concept of engineering for good calls attention to the importance of studying what engineers and engineering programs mean when they express their intent to do good, and asks what good is to be done, how, and for whom.

This work-in-progress paper motivates and introduces a mixed methods program assessment of an online co-curricular program, the Tech Stewardship Practice Program (TSPP), as a case study of engineering for good in a Canadian context. We introduce a study that will include a thematic analysis of the TSPP, interviews with developers and facilitators of the program, and analysis of participant-produced materials to explore the understandings of 'doing good' that are represented in the program as well as those that are conceptualized by the TSPP's designers and participants.

II. THE ENGINEERING CHANGE LAB AND TECHNOLOGICAL STEWARDSHIP

The TSPP was created by Canada's Engineering Change Lab (ECL), which itself was launched in 2015 as a collaborative, national effort that would focus on the potential of engineering as a "force for social good" [9]. The ECL was founded by members of Engineers Without Borders Canada (EWB Canada), Engineers Canada, and Reos Partners. From 2016-2020, the ECL was based at EWB Canada and was managed and funded

by a "Champions Team" that included two university faculties of engineering, EWB, and the energy company Suncor. In 2020, the ECL became housed within the MaRS Discovery District, a Toronto-based non-profit organization that supports tech startups and entrepreneurs. As of 2022, its member base and stakeholders have expanded to include numerous universities, private companies, public sector agencies, and engineering associations across Canada.

The ECL advances *technological stewardship*, or tech stewardship, as a guiding principle. Through its accompanying set of concepts and behaviours, tech stewardship is intended to influence Canada's engineering community towards social good. Tech stewardship has formed the basis of the ECL's programming since 2017 [9]. During this time, the ECL has facilitated workshops for engineering faculty, students, and professionals that introduce participants to tech stewardship and invite them to consider how they might implement its associated practices in their own contexts.

The concept of tech stewardship draws explicitly from the Tech for Good movement [10], which has been critiqued as technologically determinist and fixated on tech solutionism [11]. However, tech stewardship also draws heavily from value sensitive design [12] and from a wide array of work in tech ethics, Science and Technology Studies (STS), and engineering education that recognizes technology and society as co-constructed [13], and technologies and engineering as value-laden, rather than neutral [14]. Tech stewardship promotes a value sensitive approach to technological development, wherein adherents of the concept – "tech stewards" – must consider the values that are important to them, in connection with the values that are embedded in technologies, as an integral part of the design process.

Tech stewardship is defined by a set of core ideals – originally defined as eight "principles" – that tech stewards should put into practice as they participate in technological development [15]:

- **S**eek Purpose
- **T**ake Responsibility
- **E**xpand Involvement
- **W**iden Approaches
- **A**dvance Understanding
- **R**ealize Diversity
- **D**eliberate Values
- **S**eek Regeneration

In 2022, as the TSPP was developed and piloted, ECL leaders streamlined and modified the tech stewardship principles and replaced them with four tech stewardship *behaviours*: "Seek purpose," "Take responsibility," "Expand Inclusion" and "Work to regenerate" [16]. These behaviours now form the core of the TSPP.

III. The Tech Stewardship Practice Program

In January 2022, the Engineering Change Lab began offering the TSPP, an online program that engages participants in a series of reflective learning exercises, with the goal of introducing them to the concepts and behaviours of tech stewardship. The TSPP is a free, 16-week (approximately 18 hours total), online, co-curricular program that is open to all undergraduate students at Canadian universities. The program builds on the workshops and other materials that the ECL has created and facilitated since its launch, which have introduced and developed both the concept of tech stewardship and pedagogical approaches to teaching tech stewardship practices. The TSPP does not confer academic credit; however, participants who complete the entire program will receive a micro-credential upon completion of all TSPP modules.

Students may register for the TSPP individually and of their own accord, but the majority of the more than 2000 participants in the Winter 2022 and Summer 2022 cohorts were recruited through university engineering programs, or by faculty or staff members with established connections to the ECL. Student participants included representatives from most Canadian provinces, and from accredited engineering programs across the country. Some students completed the program independently, but many experienced it as a required or suggested component of a course, internship program, or other co-curricular activity. Several members of the ECL's network of university faculty, staff, and administrators implemented some or all of the TSPP modules as components in their courses or other programs.

The TSPP content consists of foundational, iterative reflective exercises, followed by weekly "practice" exercises. For instance, in a foundational module titled "What is Technology?", participants begin by watching a brief video that introduces the topic/question for the week. Then, individual reflection prompts guide participants to respond to a series of related questions, e.g. "What is the most important technology you've used in the past 24 hours?" and "What technology would you argue has had the greatest positive impact on society and why?" Participants post their responses in a common forum, and then view a second short video that shows responses to the same individual questions from faculty and industry professionals. Next, a final video presents a key takeaway from the module – the TSPP's definition of technology. Finally, students are directed to a survey that asks them to consider their fellow participants' responses to the initial prompts, as well as to share any questions they have. The initial set of 11 foundational modules is followed by four weekly practice modules, each of which asks participants to set intentions, view inspirational examples, and share their own story related to one of the tech stewardship principles.

The TSPP content focuses on individual reflection and behaviour change, but the ECL has systemic ambitions of effecting a culture shift within engineering. While the TSPP's creators at the ECL have targeted engineering schools and students with the current version of the program, the content of the platform itself is not specific to engineering, and undergraduate students from any field, discipline, or program are eligible to enroll. In addition, the ECL hopes to bring a

version of its tech stewardship programming to industry environments and other contexts outside of academia.

IV. The TSPP as 'Engineering for Good'

The TSPP and its underlying concept of technological stewardship are in one sense a clear example of engineering for good. The program and the concept take social good – expressed throughout the program as the idea of technology being "beneficial for all" - as a primary motivation and an intended outcome. Without providing an explicit definition of what 'doing good' entails, the TSPP materials include testimonials from existing "tech stewards" that demonstrate stewardship principles and behaviours in action.

However, differences also exist between the TSPP and other approaches or programs that have been classified as engineering for good. Most obviously, the TSPP is not specifically an engineering program. The program's coordinators targeted mainly engineering programs and students with the initial TSPP offerings, but the first intake also include participants who are not engineers, and the TSPP coordinators plan to expand the program considerably in the future to a wide array of disciplines. Further, rather than discussing engineering in particular, the TSPP centres technology. The materials do not name the profession of engineering, asking its participants to instead categorize themselves along a spectrum of "can we do it?" vs. "should we do it?" professions and fields. This makes technological stewardship unique among the varied examples of engineering for good – which include humanitarian engineering programs, coalitions for engineering and social justice, and community development projects - most of which focus specifically on engineering and/or engineers [8].

The TSPP does not fully deprioritize other common engineering aims such as efficiency or innovation. Instead, it borrows from approaches like responsible innovation [17], which insist that technological innovation, when managed and conducted appropriately, is a helpful priority that can and should lead to social good. This "both/and" approach, which the TSPP materials explicitly name and promote, further distinguishes the ECL's approach from other types of engineering for good.

Finally, the TSPP is an example of integrated, operationalized STS and tech ethics. It moves, purposefully and swiftly, from the level of critique to the level of action, asking its participants not only to identify and discuss issues, or critique existing technologies, but to enact and even document new technological development practices. As such, the TSPP could be considered an example of type of "critical participation" or "making and doing" for which STS scholars have recently advocated [18]. At the same time, the TSPP is an avenue for critical participation that has largely removed critical scholars and practitioners from real-time engagement with participants. The TSPP relegates its live interactions to optional virtual conversations and offers little opportunity for facilitators or creators of the program to question, support, critique, or engage directly with participants. In studying what participants take away from the program, we must analyze the TSPP in contrast with the many existing approaches to engineering instruction for ethics, equity, and positive social impact, and consider the affordances, potentials, and limitations of its format.

V. Proposed Study Design

The TSPP, and the concept and practices of tech stewardship as espoused by the ECL, are based on a value-sensitive approach to technological development that encourages engineers to consider how their own values relate to the values of the technologies that they create and the organizations they work with and for. However, the TSPP does not make explicit arguments about which values are more beneficial or desirable, with limited exceptions such as promoting inclusivity. Therefore, we argue that it is important to analyze and reflect on the values implicitly embedded in the TSPP itself. The TSPP draws its materials and messaging from many different sources, and the program aims to reach a large percentage of the Canadian engineering community. As such, it is important to explore and analyze the type of 'good' that the TSPP seeks to promote and the ways that the program reflects these embedded values. For the initial stage of this study, we propose a mixed methods program assessment of the TSPP, with the aims of 1) understanding the values that are embedded in and expressed by the program, and 2) studying how participants experience and react to the program materials, to assess the messages and content that participants take away from the program and the effective of the program's delivery.

First, we propose to conduct a qualitative content analysis of the TSPP curriculum. We will analyze the program contents, including the exemplars provided via the videos, to ask how the curriculum expresses and implicitly defines "social good." Second, we will conduct semi-structured interviews with TSPP creators and coordinators associated with the ECL. This part of the study aims to understand how the ECL's vision and the TSPP content have evolved, what the goals of the program's creators were, and if/how these goals have changed as the project has progressed. Finally, we will conduct a qualitative content analysis of program participants' written reflections to determine participants' conceptions of social good, as well as their understandings of tech stewardship. We will look for differences and similarities between participants' conceptions of 'doing good' and the program creators' intent, and between participants' and creators' understandings of the meaning and importance of tech stewardship. The analysis will examine outlier cases as well as frequent and recurring themes, to analyze a range of participant experiences with and responses to the TSPP.

VI. Future Work

As this study continues, comparing and contrasting the TSPP and tech stewardship with other approaches to 'engineering for good' will be an important way to contextualize the program's content and values. A future stage of this work may also include a longitudinal study of TSPP participants and their engagement with tech stewardship after they complete the program.

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