Guest Editors' Introduction

Technological Stewardship and Responsible Innovation: A Mindset, an Ethos, and an Interdisciplinary Undertaking

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■ IN THE FOREWORD to *Responsible Innovation: Managing the Responsible Emergence of Science and Innovation in Society*, the concept of responsible innovation is pitched as a necessary counterpoint to "innovation's systemic irresponsibility," an undertaking that aims to "nudge [technologies'] trajectories in various ways toward responsible, desirable futures" [1, p. xii]. Within the leading journal *Responsible Innovation*, the concept is often treated as synonymous with responsible research and innovation (RRI); indeed, the European Commission suggests an overlapping set of aims in its description of RRI as a "comprehensive approach" to developing research methods and new technologies, one that:

> "allow[s] all stakeholders [to be] involved … at an early stage (A) to obtain relevant knowledge on the consequences of the outcomes of their actions and on the range of options open to them and (B) to effectively evaluate both outcomes and options in terms of societal needs and moral values and (C) to use these considerations (under A and B) as functional requirements for design and development of new research, products and services." [2, p. 6]

A key point of emphasis in these descriptions (and others like them) is the notion that responsible innovation entails a particular mindset—a mindset that treats all innovation, tech innovation, in particular, as inherently possessed of ethical dimensions. Furthermore, aligned with this recognition that technology is normative is a conviction that it is essential to navigate the development and deployment of technological innovation in ways that consider and take responsibility for its benefits and consequences. The call for responsible innovation, in other words,

is a call to address and account for technology's short- and long-term impacts within social, political, environmental, and cultural domains.

Technological stewardship stands as the corollary of this mindset: a commitment to anticipate and mitigate technology's potential for disruption and especially harm and to guide innovation toward beneficial ends. Adopted from the domain of engineering ethics, where it "involves taking a value sensitive approach to embedding ethics, sustainability, and EDI (equity, diversity, and inclusivity) principles into the practice and culture of engineering" [3, p. 34], technological stewardship belongs to any who would take up the mantle. The term has been championed in recent years by the Canadian-based Engineering Change Laboratory. The laboratory has developed a technological stewardship practice program that prompts students in tech (and tech-adjacent) fields to learn about and reflect on the role of tech stewardship in their personal and professional lives. To be a technological steward means to be committed to an ethos of *care*: to understanding the systematic impacts of innovation and its philosophical dimensions, and to cultivating the capacity to apply this knowledge to drive development into new realms of humane engineering and design. To be a steward is to see care as the foundation of one's professional identity and not as an add-on or bonus. Technological stewardship is therefore about an optimistic turn toward the future of more responsible innovation—about recognizing the possibility for technology to transform culture and civilization and to steer away from the maelstrom of unfettered innovation.

The task of putting into productive language the concepts that underpin this ethical turn in innovation discourse and practice has frequently been taken up by scholars with disciplinary homes in the humanities and social sciences—fields adjacent to, but often siloed from science, technology, engineering, and math (STEM) disciplines. Because change and action often depend upon a shared vocabulary, this work, along with its dissemination beyond non-technical audiences, is vital to the broader project of fostering a widespread culture of technological stewardship. Indeed, dialogue and collaboration across diverse perspectives (be they disciplinary, economic, cultural, or otherwise) is essential for developing actionable technological solutions that attend in responsible ways to the evolving needs of today's society.

In light of this nexus of interrelated values and goals, the 2021 IEEE International Symposium on Technology and Society (ISTAS21), the flagship conference of the IEEE Society on Social Implications of Technology (SSIT), offered an exciting opportunity to call together a diverse group of academics and professionals to discuss their novel and timely approaches to problems that have been broadly conceived within this responsible innovation/technological stewardship/ethics-focused framework.

The ISTAS21/ETHICS-2021 "Scene"

"ISTAS21: Technological Stewardship and Responsible Innovation" was jointly hosted by the University of Waterloo and the University of Guelph (Ontario, Canada) from 28 to 31 October 2021. Ongoing COVID-19 concerns prompted the organizing committee to run the conference as a fully virtual event, and although participants missed out on in-person socializing opportunities, the online venue enabled the largest ISTAS to date. Over 550 participants were registered, including just over 200 presenters, more than 65 volunteers, and representatives of over 175 different institutions and organizations from around the globe. Thanks, in part, to generous contributions by conference patrons, over 150 students were able to register for free, providing a valuable opportunity for the upcoming generation of tech professionals to hear from and engage with senior scholars and other leading experts in the conference's six thematic focus areas: automation and artificial intelligence (AI), health systems, privacy and security, technology policy and governance, sustainable cities and communities, and ethical and human values in emerging technology.

The ISTAS21 program featured: five keynote speakers, whose talks covered the full breadth of the conference's themes; 14 special sessions, several of which were organized by partner organizations at IEEE and the Universities of Waterloo and Guelph (and are now available for viewing on the SSIT channel of IEEE.tv); 20 paper panels, work from which is published in the ISTAS21 Conference Proceedings; and five networking events targeting students and young professionals, which were organized in collaboration with student groups at SSIT and the University of Waterloo. These sessions offered participants valuable opportunities to explore contemporary issues in the conference's often-interdependent focus areas. Highlights included keynotes on: equity

topics from science and technology studies (STS) and virtue ethics perspectives (Safiya Noble and Shannon Vallor, respectively); modern-day espionage (Ron Deibert); as well as the implications of machine learning and modern technology for future directions in environmental stewardship (Adam Greenfield) and healthcare diagnostics (Carolyn McGregor). As can be glimpsed from the diversity of keynote topics, "Technological Stewardship and Responsible Innovation" is not just the domain of a single discipline, but can be viewed as the harmonious assemblage of several; this multifaceted terrain was also evident in the breadth of topics on display in ISTAS21 special sessions and paper panels, which ranged from robots for ethical care to racist data artifacts; from ethics education to emerging technologies; and from water management to (cyber-) warfare.

ISTAS21 was enriched through a collaboration with the IEEE International Symposium on Ethics in Engineering, Science, and Technology (ETHICS), a conference series with which IEEE SSIT has been associated since its inception in 2014. In partnering with ISTAS21 and selecting "Engineering and Corporate Social Responsibility" (CSR) as this year's ETHICS-2021 theme, the organizers brought an additional important set of perspectives to the conference program, emphasizing the possibilities, tensions, and complexities that emerge with attempts to integrate responsible innovation ideals and tech stewardship goals within the corporate sector. The dedicated ETHICS-2021 track included a keynote that showcased how the "Top of Mind Ethics" (TOME) heuristic can enable tech organizations to better integrate ethics into their workflow (Will Griffin) and seven special sessions, which are now available for viewing on the SSIT channel of IEEE.tv, as well as four paper panels, content from which comprises the ETHICS-2021 Conference Proceedings. Attendees at these sessions gained insights into the diverse ways in which individuals, teams, and organizations are striving to mobilize the concept of CSR beyond its often-assumed status as a mere catchphrase or attempt at a "value add" in the eyes of stakeholders. Speakers interrogated how the concept might instead (or, at least, *also*) serve as a prompt motivating corporate stakeholders to actively consider and take seriously some of the core tenets of responsible innovation and technological stewardship, that is, the fact that technological developments have a real impact on humans, societies, nonmoral agents (such as animals), and the environment and that corporations have a significant role to play in shaping those impacts.

As an added bonus, ISTAS21 registration included access to the Second Annual International Workshop on Artificial Intelligence for Equity (AI4Eq), a one-day "preconference" symposium organized by Jeremy Pitt and Maria Tzanou on the theme "Against Modern Indentured Servitude." Recordings of the workshop's two keynote addresses and four panel sessions are available on the SSIT channel of IEEE.tv, and the AI4Eq speakers expand on their remarks in the June 2022 special issue of this magazine (highly recommended viewing/reading!). The symposium raised crucial questions about and offered incisive perspectives on some of technology's most urgent and damaging consequences for citizens of our 21st-century world, beautifully setting the stage for the conversations about responsible innovation and technological stewardship that unfolded over the four-day ISTAS21/ETHICS-2021 conference.

Diverse perspectives, yet common aspirations

In navigating the process of selecting, reviewing, and providing feedback on contributions to this special issue, we have embraced the interdisciplinary ethos of the conference's overall theme. We came together as a diverse group of practitioners, scholars, and educators whose areas of expertise range from the applied fields of computer science and engineering to the social science fields of STS and engineering pedagogy to the humanities fields of communication studies and literature. Before embarking on the daunting task of organizing a flagship, international conference (and then putting together a special issue) during a global pandemic, most of us had never (and still have not) met in person. Yet, thanks to both our shared commitments and our diverging approaches to the study and practice of engineering, ethics, pedagogy, and philosophy, we have learned from one another and developed as thinkers in profound ways over the past two years. We have come to appreciate the different lenses through which we each perceive the world as we strive in varied ways to cultivate and promote the mindset required for responsible innovation. The ISTAS21/ETHICS-2021 conference offered a space in which to spark those types of mutually instructive

and illuminating interactions, and we hope that the diverse topics and perspectives gathered together here will provide readers of *IEEE Technology and Society Magazine* with a similarly generative opportunity to experience the cross-disciplinary insights that are possible when we take time to engage with, listen to, and learn from one another.

Given the array of topics under discussion at ISTAS21/ETHICS-2021, we found ourselves spoiled for choice when it came time to put this special issue together. We elected to invite submissions from a set of authors whose research covered the full range of conference themes, and we are thrilled with the work they have produced as they have expanded and developed material from their conference presentations. Their papers appear here in the same order that they were presented during the conference.

In our first feature article, "Rethinking the Firm: Finding the Space for Ethics in Innovation," Steven Kelts offers an expanded version of the talk he gave as part of the opening ETHICS-2021 paper panel. His argument challenges the conceptions by economists in the 20th century (e.g., Friedman) that there is no place for CSR—ethical obligations inclusive—in the "firm," whose sole motive is the creation of profit. Mobilizing the example of the modern-day tech company and its workflows, including the principles of knowledge-sharing in the contemporary "Agile" way of working, as well as the requirements for constant human-centric innovation, Kelts presents a compelling argument about how, "by aiming at grander, human-affecting objectives," tech companies are actually doing "ethics-affecting" work, for better or for worse.

Next, Jordan Schoenherr engages with several conference themes, "healthcare systems," in particular, as he explores the ethically complex issues that have emerged—and have yet to be fully addressed by either tech developers or policymakers—as healthcare technologies are adopted more and more frequently for personal use by nonexpert communities and consumers. His article, "Folkmedical Technologies and the Sociotechnical Systems of Healthcare," illustrates how the systems and practices already at play for evaluating medical technologies within expert communities will need to be both adopted and creatively adapted within nonexpert, folkmedical contexts, emphasizing, in particular, the blurry status of "prestige" as an indirect marker

of trust upon which consumers often implicitly rely. This argument emerges through detailed discussions of several specific folkmedical technologies, including diagnostic phone apps and online public-health prediction tools. Schoenherr's analysis advocates for understanding folkmedical technology as an area that demands more rigorous standards of trust and reliability, given the numerous social and ethical issues (i.e., individual health outcomes, broader health system effects, personal data privacy, questions of mis- and dis-information, etc.) associated with its uptake and application.

As an example of how the ISTAS21 highlighted the surprising and counter-intuitive ways in which technological and social innovations can intersect with one another, Neha Chugh's "Risk Assessment Tools on Trial: AI Systems Go?" identifies the problematic consequences of relying on tech innovations in the judicial system. Courts in Canada and around the world use risk assessment tools to attempt to standardize bail, sentencing, and parole decisions, with a view to reducing subjectivity and bias in the decision-making process. However, standardized risk assessment tools without human subjectivity are dangerously flawed, as they perpetuate systems of bias and discrimination that exist within foundational datasets without creating space for an evaluation of historical contexts such as colonization, xenophobia, and racism. Chugh examines the 2015 case of *Ewert v Canada* specifically, to argue that existing datasets within the judiciary context disproportionately criminalize Black, Indigenous, and persons of color, despite there being no evidence to suggest a heightened presence of criminality within these communities compared to white communities. Chugh sounds the alarm with her claim that technological innovations such as AI and machine learning further obscure biases within the data with their promise of objectivity and efficiency in an overburdened judicial system. Putting a halt to the use of these risk assessment tools would represent an important step in making progress toward antiracist goals and reconciliation.

Turning to the realm of media and communication, Joe Masoodi and Sam Andrey's "Understanding the Use of Private Messaging Apps in Canada and Links to Disinformation" presents results from a research project that surveyed a statistically representative sample of Canadians to gain insights into the ways in which false information can spread

through private messaging apps. Their piece lays important groundwork that furthers our understanding of how this specific technology (as opposed to more frequently studied, semipublic social networking sites) influences users and plays a role in the spread of false information online. In particular, their findings related to the increasing use of private messaging apps, the frequency with which users encounter both suspected and confirmed false news, and the disproportionately high incidents of hate speech reported by members of minoritized groups provide important new data with potential relevance for platforms and governments who seek to develop future policy tools. Overall, this piece offers a fascinating window into a poorly understood and under-researched area that is critical for maintaining an informed populace.

The conference theme "technology policy and governance" is even more explicitly the focus of Sarah Spiekermann and Till Winkler's "Value-based Engineering with IEEE 7000," which introduces readers to how organizations can build responsible and ethically founded systems with the "Value-based Engineering" (VBE) approach that is central to the IEEE 7000 standard. This article is coauthored by the vice-chair of the IEEE 7000 working group at IEEE Standards (notably, Spiekermann presented in both ISTAS21 and ETHICS-2021 panels); it provides readers with expert insights into how IEEE has standardized a process model by which engineers and technologists can address ethical consideration throughout the various stages of system initiation, analysis, and design. The precedent-setting standardization of ethical practices described in this piece is a must-read for anyone interested in how ethical concerns in engineering design are being standardized in real-world, action-guiding ways that move beyond the familiar broad principles outlined in traditional codes of ethics.

Our final feature article focuses on the theme of engineering ethics pedagogy, a topic that emerged as a key thread connecting several ISTAS21 and ETHICS-2021 sessions. Alexandra Morrison and Charles Wallace's piece, "Making it Strange: Disrupting Assumptions About Technology and Ethics in Engineering and Computing Education," reflects on their experiences and strategies in teaching ethics at the tertiary level. Defamiliarization is a technique the authors use to get students out of their comfort zone and challenge their existing worldview as technologists and scientists. They propose that ethical concerns cannot simply be "patched" nor "engineered" away; rather, students have to "reconceiv[e] … ethical theories as an array of alternative lenses, each with distinctive strengths and limitations," to be fully aware of the impact of the technology they help build. Through several illustrative examples, including their application of van de Poel and Royakkers' *Ethical Cycle* framework, Morrison and Wallace explain how they go about diversifying—even problematizing—students' views about ethics and technological innovation. Their descriptions of students' reactions to this and other iterative design models will likely be of value to other instructors, and their collaborative approach to pedagogical innovation exemplifies the type of cross-disciplinary partnership that the ISTAS21/ETHICS-2021 conference theme strives to cultivate.

In addition to showcasing this rich slate of peer-reviewed papers, we wanted this special issue to provide readers with a glimpse of the range of issues that special sessions—a core element of the ISTAS21/ETHICS-2021 program—brought into conversation with the "Technological Stewardship and Responsible Innovation" theme. We, therefore, invited presenters from four special sessions to contribute commentary pieces that would represent this dimension of the conference. Our thanks go out to these authors for offering such incisive and compelling snapshots of the important work they are undertaking and disseminating in the areas of digital design with children in mind, CSR, flood resilience, and PeaceTech. If their writing here piques your interest, we encourage you to view the full recordings of their sessions (and many more!) on the SSIT channel of IEEE.tv.

The commentary section opens with a contribution from Katina Michael and Nishan Chelvachandran, who presented on a Thursday session organized by the IEEE Standards Association titled "Designing Offline/Online Experiences with Children in Mind." The session's conversational experience is reflected in the format that appears here, where Michael and Chelvachandran engage in a dialog to share their thoughts on the importance, the challenges, and the future directions of their work on the IEEE 2089-2021 Standard for an age appropriate digital services framework. In reflecting on the Standard's connection to the ISTAS21 theme, they emphasize the key role that codesign needs to play in child-focused tech development, and they offer insights into the

ways in which standards, although they do not wield legal power, can nonetheless function as a proactive tool for promoting equitable design practices and cultivating more widespread expectations for responsible innovation.

The next commentary comes from a scholar whose work has shaped the field that inspired this year's ETHICS-2021 theme, and who headlined a Saturday "Author Meets the Critic" session focused on her new monograph, *Extracting Accountability: Engineers and Corporate Social Responsibility* (2021). Jessica Smith highlights the essential role of corporations in our everyday lives, and thus the increasing importance of CSR. However, she points out an inherent conflict of interest in CSR as a model of governance, as corporations aim to maintain profitability while simultaneously attempting to assuage public concerns regarding the social and environmental consequences of corporate decision-making. Smith notes that one of the viewpoints that further paints CSR in a negative light is that it is often thought of as a rigid set of policies for firms to follow and thus "nothing more than disingenuous greenwash." Instead, Smith uses her ethnographic research to argue for the repositioning of CSR as an ever-changing "relational practice" of accountability between corporations and other actors. This reframing allows CSR to be approached as a dynamic resource that opens up the process of corporate decision-making for public input and recenter the human agents behind these conversations.

The third commentary draws from a Saturday special session, "Water and Cities: Get in the Game!," organized by the University of Waterloo Turkstra Chair in Urban Engineering. Here, Evalyna Bogdan and Shaieree Cottar describe a novel, game-based pedagogical approach to teaching flood resilience—a wicked problem that demands increasing attention as extreme weather events become more frequent. While the article is most explicitly focused on describing the "serious" role-playing game situated at the center of its pedagogical intervention, which was piloted at a Canadian university, the piece also involves broader considerations of how to teach students to think responsibly about innovation. More to the point, it emphasizes how serious games can teach students to meaningfully engage with systemic issues (in this case, resource management and

policy development) while assimilating technological stewardship values in the process.

We close out the special issue with a commentary by Paul Heidebrecht, organizer of a Sunday afternoon special session titled "More than Tech for Good: PeaceTech at Waterloo and Beyond." This short piece manages a lot in few words. First, it situates PeaceTech as both a term and a practice within the broader tech for good movement, emphasizing its status as an approach to achieving peace through technology. Heidebrecht then explains the term's origins and points to several specific instances of PeaceTech in practice, including a brief discussion of how the Kindred Credit Union Centre for Peace Advancement at the University of Waterloo (an ISTAS21 Partner Organization) engages with it. He concludes with a suggestion of what PeaceTech could become. Essential reading for anyone seeking a critical and brief introduction to the topic.

ACROSS THE BROAD scope of content on display in this special issue, the contributions are united by their commitment to improving innovation by first articulating and then addressing the complexity of its impacts. Each article highlights the critical process of mediation that comes before and after the impacts of innovation occur, and in so doing underscores how a technological stewardship- and responsible innovation-based mindset can serve as an ethos that orients one's ethical and professional conduct. The special issue's range also emphasizes that terms like "technological stewardship," "responsible innovation," and even "ethics" belong to more than any single domain or discipline. Moreover, many of these authors report on works in progress, often with provisional conclusions. This is a feature, not a bug. To be innovative is to be at the cutting edge of introducing something new, so responsible, technical innovation must remain an iterative process of design and implementation to meet the needs of the future. As Morrison and Wallace helpfully put it, "ethical considerations are necessarily ongoing because the worldly field is perpetually in flux; new people and new technologies mean new contexts and new ethical considerations. Ethics is ultimately about how to live in the world together and so cannot be reduced to individual moral reflection and decision." Our aim then with this special issue is to expand what these terms can mean, how they can be put into practice, and whom they should serve.

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