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SOCIOLOGICAL, POSTCOLONIAL, AND CRITICAL THEORY FOUNDATIONS OF ENGINEERING ETHICS EDUCATION

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Introduction

Traditionally, engineering ethics has been viewed as belonging exclusively to the domain of philosophy. In this chapter, it is argued that engineering ethics has much that can be learned from sociological approaches. This is especially important as all engineers are also tacit sociologists; they form an opinion about the social world in which they dwell, socialize, and work – and into which they imagine their engineered artifacts will be deployed. A greater understanding of formal sociology enables engineers to contextualize their practices, understand problems, and generate engineering ideas in a more interdisciplinary and multi-dimensional way. Sociology also helps us understand how and why technology ethics (and the role of engineers) change over space (culturally) and time (historically), along with the structural changes of social systems and the history of ideas. Sociology gives us tools to deconstruct simplistic views when working with students, such as technological determinism and the belief technical design is value neutral. This chapter presents what we regard as the three most crucial sociological approaches and their potential contributions to engineering ethics education: critical theory, postcolonial theory, and Science, Technology, and Society (STS) studies.

Critical theory is associated with numerous intellectual traditions seeking human emancipation. In respect to its implications for engineering, if the potential liberating powers of technology are to be realized, this will only occur through human-designed social change based on a larger dialogue about goals and values (Mitcham & Briggle, 2009). Postcolonial studies provide a decentered, diasporic rewriting of earlier nation-centered imperial grand narratives of technoscientific modernity. STS offers a critique of technological determinism and solutionism and their correlate deficit logic, and of artifacts that are assumed to be void of socio-political agential powers. All these intellectual and research traditions provide resources for reflecting on and following ethical pathways in engineering and engineering education.

This chapter suggests ways to conceptualize the 'self-knowledge' of engineers, focusing on the social, political, epistemological, and ontological aspects of common sense and the frequently unarticulated, taken-for-granted social practices and ethics of engineering (Mitcham, 2014). At the same time, we ask whether other worlds, ways of life, social imaginaries, and material practices

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are possible, and how such potential futures could be realized with the help of a reflective engineering education and practice.

Before providing an overview of the three sociological approaches, we open the chapter with positionality statements and remarks on the link among ethics, engineering, and society. The two last sections expose paths to integrate sociological approaches in the theory and practice of engineering ethics education.

Positionality

The first author, Robert Braun, was born, raised, and educated in Hungary during "socialist times" (the Soviet/Russian occupation of Eastern Europe, 1948–1989). He comes from an assimilated Jewish academic family. Coming of age in the late 1980s, he was involved in activism – fighting for the human rights of Roma people in Hungary – and also in the emerging political movements around the opening up of local politics and the collapse of the Soviet Union. Robert was involved in the budding left-liberal parties that emerged; he participated in the democratic transition. He left for the United States in 1992 to do Ph.D. coursework and a dissertation (Rutgers University) on a fellowship offered by the Soros Foundation; his academic carrier started at Eötvös Lorand University, Department of Jewish Studies thereafter. He later joined the philosophy department of Corvinus University, the leading economics and social science university in Budapest. Parallel to his academic work, Robert remained active in politics and held a number of public offices and various (mostly founding) positions in technology and politics-oriented business enterprises. In 2015, he moved with his family to Vienna, Austria, where he joined the faculty of the Institute for Advanced Studies. His research moved into the direction of Science and Technology Studies with a focus on the ontological politics of technology transitions and quantum social science. His specific interest is in the Anthropocene, not as a geological epoch but as a political meta-apparatus of world-making. He has researched and published extensively on one of the core apparatuses of the Anthropocene, automobility and its politics; his current research moves more in the direction of applying quantum theory to understand accident events in automobility.

The second author, John B. Kleba, was born in Brazil during the dictatorship (1964–1984). In 1984, he began studying Social Sciences at the Federal University of Santa Catarina, South Brazil, protesting for democracy among one million citizens nationwide and engaging in the ecological movement. John's postgraduate work was directed to the critique of 'development.' At that time, he spent one month living within and studying the Landless Workers' Movement. Shifting between disputing sociological theories and clashing streams of activism, he learned that an open mind is essential when striving for a proactive attitude toward social change. In 1992, he moved to Germany earning a Ph.D. in Science and Technology Studies in Bielefeld and working in Bremen as a research assistant in law and society. He investigated issues such as the access and benefit-sharing regimes (genetic engineering, conflicting worldviews, regulatory frameworks) and pollution double standards in the trans-national chemical industry. In 2005, he moved with his family to Brazil to work at the Aeronautics Technological Institute (ITA). His research included working with Indigenous Peoples, Quilombolas (slave-descendant communities) and other social movements, especially related to the privatization of the commons and the clash of traditional medicinal versus Western knowledge systems. The invisibility of people made vulnerable and marginalized by colonialist structures, their ways of knowing and existing, and the multitude of critiques raised in the Global South have been constantly present in his reflections. At ITA, he established the Citizenship and Social Technologies Lab (LabCTS), which has engaged hundreds of engineering

students in sociotechnical interdisciplinary projects in partnership with civil society organizations and public schools.

A descendant of nineteenth-century European colonial settlers, the third author, Richard Randell, was born in Melbourne, Australia. Richard completed his school education in Adelaide, South Australia. His high school years coincided with the last years of Australia's involvement in the Vietnam War. Out of approximately 600 students, 6 opposed the war. Participation in anti-war demonstrations was his first contact with an alternative politics. During school vacations, he visited family in a small town 800 kilometers west of Adelaide. Several times a week, indigenous peoples visited the town by bus from two nearby mission stations administered by the Lutheran Church. Only as an adult did he discover that many of those visitors were refugees from British atomic tests that were conducted to the north, between 1956 and 1963, in Maralinga, where their people had lived for 65,000 years. His current research interest focuses on the Anthropocene, and more specifically on the various sociotechnical apparatuses with which the colonial powers have transformed much of the planet into a space of exception, where everything is permitted, and nothing is considered a crime. Maralinga is such a space of exception, created by one such sociotechnical apparatus that was brought into being by the work of scientists and engineers. After completing his BA degree at Flinders University of South Australia, he attended the University of Wisconsin-Madison, where he completed a Master of Science (MS) degree and a Ph.D. in sociology. Following a long break from academia, he returned to teaching and only later to research in the field of mobility studies and critical automobility studies.

On ethics, engineering, and society

At least since the Enlightenment, the debate on moral principles is not only about what choices are morally right or wrong or which virtues we should encourage – it is also about demanding, justifying, negotiating, and designing new forms of social co-operation today and toward better futures (Cohen, 2009; Mannheim, 1985; Wright, 2010). *How should this techno-ethical debate inform the social design in law and public policies in all current technological controversies (the regulation of artificial intelligence, autonomous mobility, and climate change policies, among others)?* Justifying, negotiating, and designing new forms of social co-operation and forging or experiencing relations are not optional. They are built into the very fabric of the world we inhabit, a world that largely has been constituted through efforts that may be placed under the umbrella term 'engineering.'

Like engineering, sociology is an ethical enterprise. Even producing accurate research findings about social reality leads to the question of which data are to be collected, analyzed, and re-arranged – which also expresses ethical-political choices. For example, policies that address inequality require data about structural racism and gender inequality. Studying social life in all its varied manifestations is the goal of sociology. Therefore, sociological studies encompass ethical goals and activities (Lybrand & Randell, 2022). They are contributing factors to social development even if they are themselves the symptoms and effects of social circumstances. Because they are working toward improvements – betterment not only of technology but also of social life as a whole – engineers are also compelled to establish, albeit usually implicitly, social theories about the social world they intend their artifacts to be written into.

Sociology and engineering are intimately interconnected, even if the connections are largely unacknowledged. Engineers are not only tacit sociologists, they are also tacit ethicists. They have specific and strong views on the social (which they perceive as lacking), and also about rights and wrongs of the social order (which they perceive as in need of betterment). Much of this chapter

may be read as a description of the tacit social theory (and lack of awareness thereof) of engineering. Whether through commission or omission, ethics is *not* optional, contingent, only occasionally relevant. Indeed, ethics is always relevant. Not only is ethics built into material artifacts and their relations, but also we exist within a world where what should be done or not done is frequently taken to be common sense. Yet what we take to be common sense is a common sense that has been *constructed* and *disseminated* by agents with their own interests. The world is neither 'out there' nor is it free of agency. The world is not a subject-independent container in which subjects and objects 'interact,' into which artifacts are engineered and deployed.

The world (or worlds) is/are constructed by the material-discursive practices of agents that create entities and their relations and categorize them into kinds: subjects and objects, living or dead, agential or void of agency. Constructs such as these are mobilized and enacted by common sense, a specific way of seeing. To the degree such agents successfully convince us of their view of 'common sense,' that too is 'engineering' – in this case, the engineering of the social world. *To develop and build or not to develop and build?* If the former is chosen, *what* and *how* it should be done always raises ethical issues, as will the latter choice. What is common sense in one given time and space is also a way of imposing particular worldviews, social hierarchies, and forms of lives over others. Amongst the agencies that construct and disseminate common sense is engineering itself.

Paraphrasing an essay on poetry by Percy Bysshe Shelley (1840, p. 57), the engineering ethicist Carl Mitcham (2014, p. 19) described engineers as the "unacknowledged legislators of the world" who, "by designing and constructing new structures, processes, and products, [influence] how we live as much as any laws." Engineers are not only unacknowledged legislators who *regulate* the world we inhabit and are a part of, they are also *co-creators* of it. Seen from the vantage point of the social, reflecting on engineering ethics is engaging with the co-creation of the world by science and its applications (Jasanoff, 2004).

Engineering is perceived by many, engineers included, to be the field *par excellence* to develop solutions to the major challenges of our time and to design and construct *desirable* (i.e., 'ethically good') possible futures. We may call this 'lyseology' – mobilizing science and knowledge production to convince policy-makers and the general public that the present possesses some form of lack that should be addressed with a new technology brought to life and offered as a solution (Braun, 2024). It is a neologism from the Greek word *lysi* (solution) and *logos* (knowledge). Lyseology is the use and misuse of science to suggest that it is in the future, populated by new but not yet existing engineered artifacts, that a better world is believed to lie. It is a modified version of agnotology (Proctor, 2008) – the use and misuse of science to produce ignorance in support of corporate interests. (Chapter 6 discusses similar topics and may interest readers of this chapter.) Support for science, technology, engineering, and mathematics (STEM) education and research at the expense of other fields is symptomatic of this belief.

Martin Heidegger (1977, p. 4) once observed that "we are delivered over to [technology] in the worst possible way when we regard it as something neutral; for this conception of it, to which today we particularly like to do homage, makes us utterly blind to the essence of technology." It is an observation that engineers would do well to reflect on, not just in the abstract but with respect to the moral choices and consequences that follow from each and every artifact that their work has contributed to realizing (Braun & Randell, 2022). Engineering is a social (material-discursive) practice that is embedded in what is commonly understood to be the social; it is part of the social, and simultaneously creates, reproduces, and sustains the social. Engineering is also embedded in what is generally termed as the natural, not only through, for example, biochemicals or radioactive materials that impact, influence, and alter life and its various forms, but also through engineering artifacts that impact life on Earth and the Earth's ecosystem. Engineering, in short, is embedded in

and constitutive of the socionatural – the hybridization of reciprocal intermingling of the natural and the social (Arias-Maldonado, 2015). Engineering ethics asks us to be cognizant of and reflect on such embeddedness and embedding.

Critical theory

'Critical theory' has both a narrow and a broader meaning in the social sciences, humanities, and philosophy. In the narrow sense, the term designates the tradition associated with the Frankfurt School. According to the School founders, a critical theory is distinguished from 'traditional theories' by pursuing human emancipation and liberation in all circumstances of domination and oppression (Horkheimer & Adorno, 1973). In its broader sense, critical theory (CT) encompasses a variety of approaches, often in association with social movements with a similar agenda, that seek to identify the dimensions of injustices, power asymmetries, and exploitation, such as gender studies, critical race theory, class analysis, postcolonial studies, and posthumanism (Bohman et al., 2023). CT combines philosophy with empirical social scientific research and is aimed at *critique,* explanation, understanding, and also changing the current state of affairs. It is *practical* – seeking emancipation – in the ethical sense of the term.

This multidisciplinary field focuses on how knowledge is formed and how power underlies these formations. As a mode of social analysis, it is concerned with language and discourse (written texts, visual images, and other discursive forms) and the relationship between power and discourse. Its central interest is the political, and its primary assumption is that the political pervades the world we inhabit, not just within discourses that claim to be non-political (Esposito, 2021) but the very materiality of the world. Artifacts themselves, as much of the STS scholarship has demonstrated, are political and enact politics (Winner, 1986). Bridges, roads, airports, computers, data, and so forth contain both the ethics and politics of their architects and operators (Jasanoff & Kim, 2015).

One way to define and delimit critical theory is to ask what it is not – to ask what a non-critical theory might be. For the subject at hand, one answer might be 'engineering.' The point is not that engineers should cease being engineers and train in another field. Rather, it is the degree to which what they develop, research, and construct – what they 'engineer' – is pursued with (or without) reflection on how what *has been* or *will be* engineered fits into or (re)constructs an irremediably political world – what the possible political, social, and co-constructive consequences might be. It is not (just) a question of telling oneself to take ethical issues into consideration. What is required are intellectual tools to do so, including familiarity with the theoretical and disciplinary fields that are the subject of this chapter, as well as an awareness of how such tools may be acquired by reflection and education. This is why we argue that sociological, postcolonial, and critical theory foundations should be part of all engineering education, under the heading of ethics or elsewhere in the curriculum. Discourse, a strategic apparatus of "the said as much as the unsaid" (Michel Foucault, 1980, pp. 195–195), creates and reproduces the social as well as the material, together with its mechanisms of power. One of those mechanisms of power is 'technology.' Perhaps the most obvious technology into which are built hierarchies of power, control, and ownership is the assembly line, whether it be the Fordist assembly line of an automobile or smartphone factory, or the kitchen of a fast-food chain (Ritzer, 2021) (see also Chapter 4 on reason and emotion). Technologies tend to reproduce already existing social hierarchies. Reflecting on power and ideological bias – for example, in relation to class, race, and gender – provides a way to identify how the politics and the ethics of engineering are intertwined with these hierarchies. Science, technology, and innovation co-produce and reinforce already existing structures of social injustice, violence, and social exclusion (Braun & Randell, 2022).

Science, Technology, and Society (STS)

STS focuses on technology–society relationships and is critical of approaches that assume that technological development follows its own logic, independently of the social world in which it is embedded. Much of the STS scholarship is critical of technological determinist accounts of technological development. The main tenet of STS is that technology and engineering are shaped by a variety of social factors and forces, and vice versa. Technologies are reflexively embedded in and embed social practices, norms, processes, conventions, discourses, and institutions. These make up what is commonly seen in sociology as building blocks of the social (social change/stability, structure/agency, cultural diversity/hegemony, etc.). This is what in STS is called technology being *co-produced* (Jasanoff, 2004) by numerous human (people) and non-human agents (norms, institutions, artifacts) and 'becoming-with' in a multi-species world (Haraway, 2008).

Innovation is understood to be embedded in a network of social institutions, forming what in STS is called a 'sociotechnical system.' It is a 'system' (e.g., a patterned network of relationships constituting a coherent, dynamic whole that exists between individuals, groups, institutions, and artifacts) composed of practices, organizations, and logics, which is the intertwined social context, composed of engineering practices and technologies. That context includes the economy, business strategies, government policies, everyday habitual practices, complex perceptual lifeworlds, and local and national cultures. If technology is rooted in the social, we must go beyond social construction accounts of technology. We need to zoom out from sociotechnical systems and focus our attention on 'the world,' of which 'the social' (e.g., the network of human subjects) is one aspect.

STS is concerned with, and, for the most part, critical of (a) the hegemonic assumption that there is one single universal world and (b) the ways in which it has been discursively constructed. This construction has involved the conversion of matter into what is commonly referred to as 'nature'; the conversion of nature into what economists traditionally call 'resources'; the transformation of the materiality of entire domains of the inorganic and the non-human into matter that can be possessed, transformed, and extracted; and the linking of matter and worlds to markets to generate growth (Escobar, 2020).

Projects to transform the sociomateriality of the world create and reproduce a modernist capture: a conversion process with a desire to solve problems. This is what we have referred to as lyseology – the use and misuse of science to suggest that, in the present, the world is populated with problems while the future could be bettered by substituting problems with (engineered) solutions. This capture is manifested in the climate emergency, which will affect humans and non-humans in myriad ways (Escobar, 2019). From an STS perspective, the world we currently inhabit that is so co-constructed can provisionally be called the world of modernist technoscience. So conceptualized, the following questions arise: *How did this hegemonic world come into existence? What are its component elements? How does it sustain and reproduce itself? What are its contradictions and contested features? Are there other (cultural, ethical-political) worlds disputing alternative developments, and with which sociotechnical consequences? And, for the subject at hand, where do engineers and engineering fit into this?* To these questions we turn in the next section.

From critical theory and STS to a critical ontology of engineering

'Ontology' traditionally has been understood to be a field of metaphysics, institutionally and intellectually located primarily, but not exclusively, in the discipline of philosophy. This is one way of thinking about ontology, as a discourse grounded in metaphysics that aims to establish the properties and boundaries of an ostensibly independently existing reality. An alternative way of thinking about ontology is as a set of practices through and by which worlds are created, not by philosophers but

by members of society – engineers, for example – in and through their routine, mundane activities. Ontologies – at least in the Global North, with its universalist and hegemonic ambitions to explain how the world ostensibly actually is – are normative; they aim to determine what is real and what is not, what counts as a thing, a signified; what counts as a representation, a signifier. Mundane practices that dwell in and enact relations in the world always tacitly construct and reproduce assumptions regarding, and reflections on, actual and possible worlds and the kinds of entities that exist within that world. For the subject at hand, this is the world of technoscientific modernity, a world that engineering, its knowledge of and assumptions about science, as well as material practices of technology, is and has been instrumental in constructing, reproducing, and sustaining. If engineers, as Mitcham intimated, are the unacknowledged legislators and makers of not just any world but the world of modernist technoscience, *what are the implications and socio-ethical consequences of this?*

Accounting for world-making requires attending to what can be called 'ontology work' (Braun & Randell, 2023). Ontology work constitutes the mundane, everyday, professional, and lay efforts that are directed to the construction and reproduction of a world – an ontology. It is the work routinely performed by human agents engaged in the continual effort at imagining, creating, and sustaining objects, artifacts, infrastructures, networks, connections, and relations that populate our everyday world. Beyond creating the artifacts that humans have no choice but to engage with, humans themselves are subjectified (Michel Foucault, 2006). We also are constructed, as specific kinds of selves with certain beliefs, ethics, and desires, selves whose desires revolve around consumption, for example.

"How and by whom," C. B. Jensen (2021, p. 101) has asked, are "such worlds … performed, maintained, challenged, transformed, or destroyed"? *How can this routine, everyday ontology work be complemented with a correlate ethics? What would the source of such ethics be?* Technoscientific modernity is a world that has been constructed and routinely sustained by shared, stabilized, and publicly performed visions about desirable futures. These visions are enacted by a myriad of human and non-human agents that form a sociotechnical 'system' or 'network' (Jasanoff, 2015). Ontopolitical power is shaped by and within these practices (A. Mol, 1999). It is exercised by those responsible for the reproduction and administration of technoscientific modernity: engineers, manufacturers, (repressive) state apparatuses (Althusser, 2014) such as regulatory and policy departments and research centers, advertising agencies, and so forth.

Technoscientific modernity, the world we inhabit, is an example of what the Situationist writer Raoul Vaneigem (1983 (1967)) called a factory of collective illusion. The allusion to the world being a factory relates to it being constructed by desires (of consumption, of lyseology, of happiness). Illusions on this account are not ideas, thoughts, or dreams that are in peoples' heads; they are as real as anything in the world. It is a factory that has created a world full of stuff, not only physical entities but also other agential powers: deterritorialized networks and relations (culture, money, media, etc.); manifold hierarchies (of material inequalities, of knowledges and beliefs, of access); desires and wants (sexual, consumerist, colonial); subjects (disciplined, controlled individuals and groups); and so forth. What is relevant here is that all these entities acquire agency that impacts the world and all of us. Imaginaries are hegemonic. They are comprised not only of visions, images, and discourses, but also the ostensibly material and physical, technological artifacts such as machines, of modernity. As Paul Virilio put it in a different context, "to invent the train is to invent the rail accident of derailment … to invent the family automobile is to produce the pile-up on the highway" (Virilio, 2007, p. 10). "Derailment," "pile-up" – what Virilio calls the "integral accident" – are as real as the technological artifacts that populate our world. It is a world captured and converted by the manifold agencies engaged in ontology work. The entity created by such work is what Timothy Morton has called a 'hyperobject' (Braun & Randell, 2021; Morton,

2016): objects massively distributed in time and space relative to humans, in which humans are trapped inside. It is the late-modern, global, capitalist world we inhabit.

It is one of the factories within what the Frankfurt School critical theorists Max Horkheimer and Theodor Adorno (1973) called 'the culture industry.' It is an industry, to extend Horkheimer and Adorno's metaphor to the subject at hand, that produces ontology. That ontology, that world (assumed to be universal, causal, deterministic), is the everyday (Western, Eurocentric) lifeworld. It is comprised of dynamic and complex relations between people and stuff that are inscribed in artifacts and their material-semiotic networks (J. Law, 1986), which create, through a continuously unraveling process, the One-World-World in which we all dwell (John Law & Lien, 2018). The activity that goes by the name 'engineering' is a form of what Heidegger called human and violent *thinging* (Heidegger , 2002, p. 7), which rests on 'rational' thinking. Western thinging not only creates objects as individual entities, but also imaginaries (shared, stabilized, and publicly performed visions about desirable futures), hyperobjects (invisible objects massively distributed in time and space), and scapes (interconnected, globalized, and hegemonic transformations into resources).

Technoscientific modernity is a deficit ontology, wherein the present is perceived as imperfect and deficient (Dewandre, 2018) but rectifiable through the unending task of techno-political lyseology. Lyseology not only suggests solutions in the future, but inscribes lack, the missing object of techno-scientific desire, into the present. The central assumption and conviction of modernist engineering is that the world possesses a lack; something is absent and needs to be added or fixed. However, what is lacking, usually subsumed in the concept of innovation, is defined uncritically, veiling, and erasing crucial dimensions of the social reality. And the idea of an amorphous 'we' does not account for sharp social differences (class, nation, culture, and rights, among others). For example, facial recognition using artificial intelligence can hide issues of structural racism (Raji et al., 2020).

It is in this corrected future that a better world, full of new and improved technologies, is believed to lie. New goods and services are assumed to improve general well-being. Challenges are typically reduced to and understood in terms of technical properties (e.g., improving efficiency). By bringing into being new artifacts, entities, connections, and networks, engineers tacitly do 'ontology work.' However, this ontology work typically lacks the self-awareness that 'thinking' creates not only of artifacts and their relations *in the world,* but also 'things,' 'entities,' 'beings,' 'agencies,' and '(intra)connections' that the world is made of (Barad, 2007). Modernist techno-science is a worldview wherein it is assumed that the future in the present can be controlled by humans, provided they possess adequate knowledge of mathematics, physics, biology, chemistry, and other (natural) sciences, and have adequate engineering skills and the means to bring that future into being. Such a worldview is modernist in that it creates and upholds binaries of nature/culture and natural/social, as well as visions of human exceptionalism, Cartesian object/subject dualism, and Newtonian physical determinism. A critical ontology (of engineering), based on work in the critical social sciences in recent decades (Latour, 2000; John Law & Lien, 2018; Annemarie Mol, 2014; Woolgar & Lezaun, 2013), calls into question such basic modernist assumptions, especially in light of current controversies related to the ontological capture discussed above by the use of, for example, nuclear energy (Jasanoff & Kim, 2009), geoengineering (Shapiro, 2021), fracking (Howell et al., 2019), and autonomous mobility (Braun & Randell, 2020), to name some contemporary techno-ethical debates surrounding emerging technologies.

Postcolonial studies – views from the Global South

Colonialism is the historical process of European (and later, also American) violent dispossession and political conquest of the rest of the world. Contemporary postcolonial studies examine how

patterns in power/knowledge and power/violence reproduce dominance over peoples, raising issues of identities, narratives, and inequalities. Fanon denounces racialized subjectivities and the foundational violence of colonialism (Fanon, 2021). Edward Said (2019) started the post-structuralist critique of Western epistemology by undermining the ideological belief of value-free knowledge, revealing that 'knowing the subaltern' (in the way this knowing has been historically established) is part of subjugating it. Recognizing the coloniality of a specific assemblage of power and knowledge as well as processes of power/violence, one manifestation of which is modernist technoscience and its ontology, *ipso facto* is to denounce how it continues to destroy community-based livelihoods, cultural diversity, and lifeworlds based on human–non-human co-existence.

Western neocolonialism acts in at least three ways against other cultural worlds: disparaging, erasing, and making it invisible. First, it downgrades 'inferior' and 'primitive' non-modern cultures, requiring of them the acceptance of a specifically Western idea of progress. That is why it is so crucial to build a critique of Western development (Escobar, 2015; Kleba & Reina-Rozo, 2021). The UN Sustainable Development Goals represent an advancement, but not enough from the point of view of postcolonial critiques (Hidalgo-Capitán et al., 2019). Second, Western neocolonialism obliterates minorities, their languages, and their living spaces, accelerating the extinction of cultures and biodiversity. Finally, by making invisible and speechless the representatives of non-Western cultures (Santos, 2011), this hegemony hinders their political articulation towards 'other possible worlds' (Castro-Gómez & Grosfoguel, 2007; Mignolo, 2018).

Today, postcolonial studies encompass numerous approaches, including milestone contributions of the Global South,[1] such as the Pluriverse (Kothari et al., 2019), the *Buen Vivir*, and the epistemologies of the South (Santos, 2011). The pluriverse and *Buen Vivir* are polysemic concepts; depending on which interpretation we accept, they either converge or diverge. Pluriversality establishes a communication between theories, social movements, and social actors of the social and political periphery engaged in a critical intercultural dialogue (Dussel, 2012, p. 26). Rooted in the idea that we live in a world with plural cosmologies and worldviews, the pluriverse encompasses a collage of anti-systemic traditions of the global South (*Buen Vivir* in Latin America, *Ubuntu* in South Africa, *Tazkijah* in the Islamic culture, *Swaraj* in India, and *Kongsi* in China, among others), along with intellectual movements of the Global North such as degrowth and ecofeminism (Kothari et al., 2019) (see also Chapter 8 on the philosophical foundations of engineering ethics education). Pluriversality is a critique of the project of a 'Western' (Euro-American, colonial, Cartesian, Newtonian) way of looking (Kuhn, 1962) that conceives of the world as being 'out there' – external and independent as well as anterior of human or non-human actions and perceptions, complete with knowable and definite, universal forms and relations of stuff that (are assumed to) populate it. The One-World World (OWW) of Western onto-epistemology, *in which* and not *of which* entities and their politics are performative (John Law, 2015; John Law & Lien, 2018), is occluding and suppresses potential alternative ontologies and subaltern indigenous subjects.

Buen Vivir (BV) (in Quechua *Sumak Kawsay* and in Aymara *Suma Qamana*), by contrast, has originated in the political struggles of indigenous peoples of the Andes region, spreading to Latin America. This intellectual and political movement is divided into three main political strands: (1) community socialism, combining local traditions with twenty-first-century socialism in governmental programs (in Ecuador and Bolivia) (Garcia Linera, 2015); (2) cultural-ancestral indigenism (Blanco & Aguiar, 2020), which opposes the Western appropriations of BV (Hidalgo-Capitán & Cubillo-Guevara, 2014); and (3) the 'pluriverse,' as explained above, which is linked to post-development (Beling et al., 2021; Escobar, 2015) and non-Eurocentric perspectives of knowing (epistemologies) (Mignolo, 2018; Reiter, 2018). Challenging misconceptions and stereotypes

around some understandings of BV (Walsh-Dilley, 2017, p. 515) and the pluriverse has provided a powerful tool for counter-hegemonic struggles.

Linking this debate to the field of ethics, the pluriverse and BV represent other ways to comprehend 'the right' and 'the good,' as well as the world(s) that they enact. Both must be considered in both research and sociotechnical projects. Both concepts strongly value reciprocity, communalism, conviviality, and redistribution, as well as priority to the commons instead of private property (Chuji et al., 2019; Kothari et al., 2019). There is a strong defense of the common good and 'building community,' in opposition to capitalism and individualism. An additional line of the pluriverse critique stands for the feministic and new leftist ethics of care (Cohen, 2009; Puig de la Bellacasa, 2017) and the rights of nature (Escobar, 2011), opposing neoliberal development, extractivism (Gudynas, 2009) and technocracy (Feenberg, 1999, p. 4).

There is strong empirical evidence that economic reciprocity involving joint work (*mutirões*) and non-monetary exchanges of Andean indigenous populations, such as those described by Acosta (2016), have an essential symbolic and ethical character for the reproduction of social ties and the consolidation of community identity. At the same time, the empirical realities of non-Western cultures are far more diverse and problematic than some postcolonial discourses tend to represent. *So, how can engineers integrate postcolonial critique in their ways of thinking and practicing?* In the following sections, we are going to explore this intricate question.

Towards critical engineering

How does the moral economy that engineers are a part of look and what is the role and potential of engineers in this process? A postcolonial and STS analysis of engineering offers us a chance to decenter conventional accounts of optimistic hegemonic and global technoscience. It may reveal and complicate durable dichotomies produced under and by colonial regimes. Dichotomies can help clarify general trends as analytical tools. However, they often disseminate oversimplified accounts blurring empirical realities that are much more hybrid, complex, and 'messy.' These binaries usually operate in terms of global/local, first-world/third-world, Western/Indigenous, modern/traditional, developed/underdeveloped, and so forth. Postcolonial and STS approaches help understand how ideas about difference – racial (white/other), temporal (modern/traditional), class (elite/subaltern), knowledge (science/knowledge systems) – are enacted, stabilized, and/or disturbed in the performance of technoscientific modernity and Western hegemonic ways of seeing and doing engineering.

Many of these binaries originate in a foundational, Cartesian, and Newtonian thinking that lies at the core of engineering – imagining the all-knowing engineering subject educated in and trained by elders who present a world seen from an observation deck constructed by a neo-positivist European scientific ethos. This *thinking* and *thinging* is political – it refers to the politics involved in the practices that shape the world that has come to possess a deficit, and to assigning subjects and objects that populate the world. Engineering in its current form is a dominantly colonialist project: it sees maniform *terrae nullius* – the surface of the Earth, sea, the mass under the surface, space, other planets, the body, the virtual, and so forth as belonging to no-one and open to (re) population and appropriation by engineering artifacts and networks. A critical, STS-inspired and postcolonial approach to engineering and engineering ethics questions the hegemonic ambitions of a European deficit ontology and its accompanying technoscientific epistemology. It opens up possibilities to engage with alternative indigenous and/or scientific ontologies (like quantum theory inspired agential realism (Barad, 2007) or Everettian Many Worlds Interpretation (Everett, 1957, 2012) and reflect on what such alternative ontologies – worlds – might be.

Critical engineering in theory and practice (education)

Taking up the challenge of the Brazilian educator Paulo Freire,[2] *what would be the point of fostering critical thinking in engineering education if there is no connection between theory and practice? Is another way of practicing and teaching engineering, one that looks at technology as ontologically and ethically biased, even possible? If so, which conditions, means, and tools would be required for such a transformation? Most importantly, for the purposes of this handbook, what would an alternative engineering teaching and practice look like?* This is a broad issue for which we do not intend to provide recipes; rather we offer a few pointers, keeping in mind that any initiative must be situated, adapted, and experimented in its local cultural, social, and institutional context.

The question of what could be done differently in training engineers is vital. Concerning critical thinking, engineering students must move "beyond deterministic models of technology and decontextualized models of engineering, where engineering decisions are understood to be 'purely' technical and without inherent social ... implications." (Nieusma, 2011, p. 22.609.7). However, the deconstruction of such naïve views of engineering students often collides with cognitive bias and is perceived as "troublesome" (Kabo, 2010, pp. 4–5). So, in this endeavor, we may need the help of learning tools such as threshold theory active methodologies (Kabo et al., 2009) and action research (Argyris & Schön, 1989).

Considering the three core dimensions of education, the 'know-what' (theories, critical thinking, reflection) should be able to connect in meaningful ways with the dimensions of 'know-how' (action, abilities, and competencies in practice) and 'attitudes' (ethical behavior and values) (Varela, 1999). In this sense, a milestone approach in engineering education is represented in the intellectual and political movements of 'engaged programs' such as Humanitarian Engineering (Smith et al., 2019) (see also Chapter 23 on Humanitarian Engineering), Engineering for Social Justice (Baillie et al., 2021; Nieusma & Riley, 2010) and Engaged and Grassroots Engineering (Cruz, 2021; Cruz et al., 2021).

Particularly in the university engineering formation, such 'engaged programs' provide us with a possible path to integrate critical thinking and postcolonial critique in theory and practice. Engaged extension programs can be implemented, including curricular and extra-curricular activities (Kleba & Cruz, 2020; Smith et al., 2019), encouraging students to work in sociotechnical hands-on projects with social movements, organizations of civil society, and communities (Timmermans et al., 2020). Such projects should respond to real needs and give priority to the vulnerable and the needy (Schneider et al., 2009). A complete project cycle can be worked on, inspired by concepts such as 'design thinking' (immersion, ideation, prototyping, testing, and implementation) (Brown & Wyatt, 2010). In working with communities, the first step is to understand local problems and possible solutions from 'the inside,' from local singularities and local knowledge. The whole project should be co-constructed with the stakeholders, following participatory research in practice (Simonsen & Robertson, 2013; Braun et al., 2022). An interepistemic approach must be assured, in which science enters into dialogue with other knowledge systems, such as indigenous and small farmer knowledge (Fúnez-Flores, 2022). The multi-dimensional aspects of sociotechnical interventions should be considered, especially thinking about the related processes of empowerment/disempowerment (Kleba & Cruz, 2021). Competencies and abilities closely related to (ethical) values such as caring (ethics of care), empathy, and listening must be trained in practice. Otherwise, they risk being ideals with no connection with social change and agency.

We should also question systemic changes 'from above' in technology and society regarding what can be done differently in government and business. Advances in legislation and policies may allow engineers to engage in critical ethical-political agendas. Ways to move environmental and social corporative governance (ESG) forward may be explored. For instance, Colorado School of

Mines offers a minor in Corporate Social Responsibility (as part of the Humanitarian Engineering Faculty), striving "to work for communities' wellbeing inside of corporate settings" in a critical way (Braun, 2019; Lucena & Kleine, 2021, p. 100).

Engineers working in the Third Sector at the crossroads with public policies show they can act as game-changers in fostering social innovation (Avelino, 2019, p. 197). Amongst a multitude of possible examples, 'Techo' works with civil engineering projects of infrastructure and participative community housing in slums in Latin America (Melo et al., 2021), and 'AlterMundi' promotes internet community networks in Argentina, at the same time politically mobilizing to steer information technologies policies towards the public interest (Prato et al., 2021).

Our starting argument in this chapter was that engineering ethics should engage with sociological approaches. Engineers, we suggest, are also architects of the social: they form a professional opinion about the social world and shape, even create, this world by engineering its semiotic-material furniture. The toolkit that sociology and its cognates – critical and postcolonial theory as well as STS studies – offer enables engineering students to think critically about artifacts, sociotechnical systems, and the sociotechnical imaginaries we inhabit. More importantly, by better understanding social mechanics, they also apprehend that technoscience (the complex practice of creating scientific knowledge, technical systems, and artifacts) creates our social reality as much as the representations of these realities. With the help of sociological approaches, engineers can develop competencies to work with the complexity and multiplicity of the social, to critically enact alternative worlds and their appliances, to be aware of values and desires – including dimensions of social justice and democracy – embedded in technology, and to design more reasonable responses to the urgencies of the present world.

Notes

1 The Global South is understood here not geographically but drawing on the line separating the world citizens who enjoy high living standards and those destitute and marginalized wherever they live.
2 Freire criticizes the separation between theory and practice in Western thought and what he called 'banking education.' For him, action and reflection blend into 'praxis,' which is an essential part of the liberating dynamic from oppressive tendencies (Freire, 1970).

References

Acosta, A. (2016). O Buen Vivir: uma oportunidade de imaginar outro mundo. In C. M. Sousa (Ed.), *Um Convite à Utopia* (Vol. 1, pp. 203–233). EDUEPB.

Althusser, L. (2014). *On the reproduction of capitalism: Ideology and ideological state apparatuses*. Verso.

Argyris, C., & Schön, D. A. (1989). Participatory action research and action science compared: A commentary. *American Behavioral Scientist, 32*(5), 612–623.

Arias-Maldonado, M. (2015). *Environment and society; Socionatural relations in the anthropocene.* Springer. https://link.springer.com/chapter/10.1007/978-3-319-15952-2_4

Avelino, F. (2019). Transformative social innovation and (Dis)empowerment. *Technological Forecasting and Social Change, 145*, 195–206. doi:10.1016/j.techfore.2017.05.002.

Baillie, C., Byrne, C., Haralampides, K., Riley, D., & Arif, S. (2021). Engineering, social justice and peace: the journey towards a movement. In C. Alvear, C. Cruz, & J. Kleba (Eds.), *Engenharia e outras práticas técnicas engajadas – vol.1: Redes e movimentos* (pp. 107–134). EDUEPB. https://doi.org/10.5281/zenodo.4908523

Barad, K. (2007). *Meeting the universe halfway: Quantum physics and the entanglement of matter and meaning*. Duke University Press.

Beling, A. E., Cubillo-Guevara, A. P., Vanhulst, J., & Hidalgo-Capitán, A. L. (2021). Buen vivir (good living): A "glocal" genealogy of a Latin American Utopia for the world. *Latin American Perspectives, 48*(3), 17–34. doi:10.1177/0094582x211009242

Blanco, J. P., & Aguiar, E. P. (2020). El Buen Vivir Como Discurso Contrahegemónico. Postdesarrollo, Indigenismo Y Naturaleza Desde La Visión Andina. *Mana, 26*. doi:10.1590/1678-49442020v26n1a205.

Bohman, J., Flynn, J., & Celikates, R. (2023). Critical Theory, Stanford encyclopedia of philosophy (Fall 2023 ed.), E. N. Zalta & U. Nodelman (Eds.). https://plato.stanford.edu/archives/fall2023/entries/critical-theory/

Braun, R. (2019). *Corporate stakeholder democracy*. CEU University Press.

Braun, R. (2024). Radical reflexivity, experimental ontology and RRI. *Journal of Responsible Innovation, 11*(1). https://doi.org/10.1080/23299460.2024.2331651

Braun, R., Loeber, A., Vinther Christensen, M., Cohen, J., Frankus, E., Griessler, E., . . . Starkbaum, J. (2022). Social labs as temporary intermediary learning organizations to help implement complex normative policies. The case of responsible research and innovation in European science governance. *The Learning Organization*. doi:https://doi.org/10.1108/TLO-09-2021-0118

Braun, R., & Randell, R. (2020). Futuramas of the present: The "driver problem" in the autonomous vehicle sociotechnical imaginary. *Humanities and Social Sciences Communications*. https://doi.org/10.1057/s41599-020-00655-z

Braun, R., & Randell, R. (2022). The vermin of the street: The politics of violence and the nomos of automobility. *Mobilities, 17,*1, 53–68.

Braun, R., & Randell, R. (2023). The political ontology of automobility. *Mobility Humanities,* 2(1), 7–22. https://doi.org/10.23090/MH.2022.07.1.2.007

Brown, T., & Wyatt, J. (2010). Design thinking for social innovation. *Development Outreach, 12*(1), 29–43. doi:10.1596/1020-797x_12_1_29.

Castro-Gómez, S., & Grosfoguel, R. (Eds.). (2007). *El giro decolonial: reflexiones para una diversidad epistémica más allá del capitalismo global*. Siglo del Hombre Editores.

Chuji, M., Rengifo, G., & Gudynas, E. (2019). Buen Vivir. In A. Kothari, A. Salleh, A. Escobar, F. Demaria, & A. Acosta (Eds.), *Pluriverse: A post-development dictionary*. Tulika Books.

Cohen, G. A. (2009). *Why not socialism?* Princeton University Press.

Cruz, C. (2021). Brazilian grassroots engineering: A decolonial approach to engineering education. *European Journal of Engineering Education, 46*(5), 690–706. doi:10.1080/03043797.2021.1878346

Cruz, C., Kleba, J., & Alvear, C. (Eds.) (2021). *Engenharias e outras práticas técnicas engajadas* (Vol. 2). EDUEPB. https://eduepb.uepb.edu.br/download/engenharia-e-outras-praticas-tecnicas-engajadas-vol-2/?wpdmdl=1836&masterkey=618ed68a15375

Dewandre, N. (2018). Political agents as relational selves: Rethinking EU politics and policy-making with Hannah Arendt. *Philosophy Today, 62*, 493–519.

Dussel, E. D. (2012). Transmodernity and interculturality: An interpretation from the perspective of philosophy of liberation. *Transmodernity: Journal of Peripheral Cultural Production of the Luso-Hispanic World, 1*(3). doi:10.5070/t413012881.

Escobar, A. (2011). Sustainability: Design for the pluriverse. *Development, 54*(2), 137–140. doi:10.1057/dev.2011.28.

Escobar, A. (2015). Degrowth, post-development, and transitions: A preliminary conversation. *Sustainability Science, 10*(3), 451–462.

Escobar, A. (2019). Thinking-feeling with the earth: Territorial struggles and the ontological dimension of the epistemologies of the South. In B. de Sousa Santos & M. Meneses (Eds.), *Knowledges born in the struggle: Constructing the epistemologies of the global south*. Routledge.

Escobar, A. (2020). *Pluriversal politics: The real and the possible*. Duke University Press.

Esposito, R. (2021). *Instituting thought: Three paradigms of political ontology*. Polity Press.

Everett, H. I. (1957). "Relative state" formulation of quantum mechanics. *Review of Modern Physics, 29*, 454.

Everett, H. I. (2012). *The everett interpretation of quantum mechanics: Collected works 1955-1980 with commentary* (J. A. Barrett & P. Byrne, Eds.). Princeton University Press.

Fanon, F. (2021). *The wretched of the earth* (60th anniversary ed.). Grove Press.

Feenberg, A. (1999). *Questioning technology*. Routledge.

Foucault, M. (1980). *Power/Knowledge: Selected interviews and other writings* (C. Gordon Ed.). Pantheon Books.

Foucault, M. (2006). *The order of things: An archaeology of the human sciences*. Vintage Books.

Freire, P. (1970). *Pedagogy of the opressed*. The Seabury Press.

Fúnez-Flores, J. I. (2022). Inter-epistemic dialogues with decolonial thought from Latin America and the Caribbean. *Educational Studies, 58*, 5–6. doi:10.1080/00131946.2022.2132397.

García Linera, Á. (2015). *Socialismo comunitario: un horizonte de época*. Vicepresidencia del Estado, Presidencia de la Asamblea Legislativa Plurinacional.

Gudynas, E. (2009). Diez tesis urgentes sobre el nuevo extractivismo. In C. L. A. E. S. Caap (Ed.), *Extractivismo, Política y Sociedad* (pp. 187–225). CentroAndino de Acción Popular. Centro Latino Americano de Ecología Social.

Haraway, D. J. (2008). *When species meet*. University of Minnesota Press.

Heidegger, M. (1977). *The question concerning technology, and other essays*. Harper & Row.

Heidegger, M. (2002). *Off the beaten track* (J. Young & K. Haynes Eds.). Cambridge University Press.

Hidalgo-Capitán, A. L., & Cubillo-Guevara, A. P. (2014). Seis Debates Abiertos Sobre El Sumak Kawsay. *Íconos - Revista de Ciencias Sociales*, *48*, 25. doi:10.17141/iconos.48.2014.1204.

Hidalgo-Capitán, A. L., García-Álvarez, S., Cubillo-Guevara, A. P., & Medina-Carranco, N. (2019). Los Objetivos del Buen Vivir. Una propuesta alter-nativa a los Objetivos de Desarrollo Sostenible. *Iberoamerican Journal of Development Studies*, 8(1), 6–57. https://doi.org/10.26754/ojs_ried/ijds.354.

Horkheimer, M., & Adorno, T. W. (1973). *Dialectic of enlightenment*. Allen Lane.

Howell, E. L., Wirz, C. D., Brossard, D., Scheufele, D. A., & Xenos, M. A. (2019). Seeing through risk-colored glasses: Risk and benefit perceptions, knowledge, and the politics of fracking in the United States. *Energy Research & Social Science, 55*, 168–178. doi:https://doi.org/10.1016/j.erss.2019.05.020

Jasanoff, S. (Ed.) (2004). *States of knowledge: The co-production of science and the social order*. Routledge.

Jasanoff, S. (2015). Future imperfect: Science, technology, and the imaginations of modernity. In S. Jasanoff & S. H. Kim (Eds.), *Dreamscapes of modernity: Sociotechnical imaginaries and the fabrication of power* (pp. 1–33). University of Chicago Press.

Jasanoff, S., & Kim, S.-H. (2009). Containing the atom: Sociotechnical imaginaries and nuclear power in the United States and South Korea. *Minerva, 47*, 119–146. doi:10.1007/s11024-009-9124-4

Jasanoff, S., & Kim, S.-H. (2015). *Dreamscapes of modernity: Sociotechnical imaginaries and the fabrication of power*. University of Chicago Press.

Jensen, C. B. (2021). Practical ontologies redux. *Berliner Blätter, 84*, 93–104.

Kabo, J. (2010). *Seeing through the lens of social justice: A threshold for engineering* (Phd Thesis.). Caroline Baillie. Queen's University, Kingston Canada.

Kabo, J., Day, R., & Baillie, C. (2009). Engineering and social justice: How to help students cross the threshold. *Practice and Evidence of Scholarship of Teaching and Learning in Higher Education, 4*, 126–146.

Kleba, J. B., & Cruz, C. C. (2020). *Building engaged engineering in curriculum - a review of Brazilian and Australian cases*. ASEE Virtual Conference 22–26 June 2020. Retrieved from https://peer.asee.org/building-engaged-engineering-in-curriculum-a-review-of-brazilian-and-australian-cases.pdf

Kleba, J. B., & Cruz, C. C. (2021). Empowerment, emancipation and engaged engineering. *International Journal of Engineering, Social Justice, and Peace, 8*(2), 28–49. doi:10.24908/ijesjp.v8i2.14380.

Kleba, J. B., & Reina-Rozo, J. D. (2021). Fostering peace engineering and rethinking development: A Latin American view. *Technological Forecasting and Social Change, 167*, 120711. doi:10.1016/j.techfore.2021.120711

Kothari, A., Salleh, A., Escobar, A., Demaria, F., & Acosta, A. (2019). *Pluriverse: A post-development dictionary*. Tulika Books.

Kuhn, T. (1962). *The structure of scientific revolutions*. University of Chicago Press.

Latour, B. (2000). *Pandora's hope: Essays on the reality of science studies*. Harvard University Press.

Law, J. (1986). On the methods of long distance control: Vessels, navigation, and the portuguese route to India In J. Law (Ed.), *Power, action and belief: A new sociology of knowledge?* (32nd ed., pp. 234–263). Routledge, Henley.

Law, J. (2015). What's wrong with a one-world world? *Distinktion: Journal of Social Theory, 16*(1), 126–139. doi:10.1080/1600910X.2015.1020066

Law, J., & Lien, M. E. (2018). Denaturalizing nature. In M. d. l. Cadena & M. Blaser (Eds.), *A world of many worlds* (pp. 131–171). Duke University Press.

Lucena, J., & Kleine, M. S. (2021). Colorado school of mines humanitarian engineering program: Negotiating the technical/social divide to create 'engineering as it should be'. In C. Cruz, J. Kleba & C. Alvear (Eds.), *Engenharias e outras práticas técnicas engajadas* (Vol. 2). EDUEPB. https://eduepb.uepb.edu.br/download/engenharia-e-outras-praticas-tecnicas-engajadas-vol-2/?wpdmdl=1836&masterkey=618ed68a15375

Lybrand, S., & Randell, R. (2022). Possible in sociology. In V. P. Glăveanu (Ed.), *The Palgrave Encyclopedia of the possible* (pp. 1178–1184). Springer International Publishing.

Mannheim, K. (1985). *Ideology and utopia: An introduction to the sociology of knowledge*. Harcourt Brace Jovanovich.

Melo, Y. V. C., Espitia, I., & Costa, J. (2021). Desenvolvimento do capital social comunitário em assentamentos vulneráveis: A experiência da organização Teto (Techo) na Colômbia e no Brasil. In C. Alvear, C.

Cruz, & J. Kleba (Eds.), *Engenharia e outras práticas técnicas engajadas – vol.1: Redes e movimentos* (pp. 219–250). EDUEPB.
Mignolo, W. (2018). Epistemic disobedience and the decolonial option: A manifesto. *Transmodernity: Journal of Peripheral Cultural Production of the Luso-Hispanic World, 1*(2). doi:10.5070/t412011807.
Mitcham, C. (2014). The true grand challenge for engineering: Self-knowledge. *Issues in Science and Technology*, *31*(1), 19–22.
Mitcham, C., & Briggle, A. (2009). The interaction of ethics and technology in historical perspective. In A. Meijers (Ed.), *Philosophy of technology and engineering sciences* (pp. 1147–1191). North-Holland.
Mol, A. (1999). Ontological politics: A word and some questions. *The Sociological Review, 47*, 74–89. doi:10.1111/j.1467-954X.1999.tb03483.x
Mol, A. (2014, January 13). Other words: Stories from the social studies of science, technology, and medicine. *Theorizing the Contemporary, Fieldsights*. Retrieved from https://culanth.org/fieldsights/other-words-stories-from-the-social-studies-of-science-technology-and-medicine
Morton, T. (2016). HYPEROBJECTS. *CSPA Quarterly*, *15*, 7–9. Retrieved from http://www.jstor.org/stable/90000650
Nieusma, D. (2011). Engineering, Social Justice, and Peace: Strategies for Pedagogical, Curricular, and Institutional Reform. 2011 ASEE Annual Conference & Exposition Proceedings, 22.609.1-22.609.12. https://doi.org/10.18260/1-2--17890
Nieusma, D., & Riley, D. (2010). Designs on development: Engineering, globalization, and social justice. *Engineering Studies, 2*(1), 29–59. doi:10.1080/19378621003604748.
Prato, A., Weckesser, C., & Segura, M. (2021). Las redes comunitarias de Internet en Argentina. AlterMundi y una red extendida durante la pandemia. In C. Alvear, C. Cruz & J. Kleba (Eds.), *Engenharia e outras práticas técnicas engajadas – vol.1: Redes e movimentos* (pp. 285–320). EDUEPB. https://doi.org/10.5281/zenodo.4908523
Proctor, R. N. S. L. (2008). *Agnotology: The making and unmaking of ignorance*. Stanford University Press.
Puig de la Bellacasa, M. (2017). *Matters of care*. University of Minnesota Press.
Raji, I. D., Gebru, T., Mitchell, M., Buolamwini, J., Lee, J., & Denton, E. (2020). *Saving face: Investigating the ethical concerns of facial recognition auditing*. AIES '20: Proceedings of the AAAI/ACM Conference on AI, Ethics, and Society, 145–151. https://doi.org/10.1145/3375627.3375820
Reiter, B. (2018). *Constructing the pluriverse*. Duke University Press.
Ritzer, G. (2021). *The McDonaldization of society: into the digital age* (10th ed.). SAGE.
Said, E. W. (2019). *Orientalism*. Penguin Books.
Santos, S. (2011). Boaventura de. *Utopía y Praxis Latinoamericana, 16*(54), 17–39.
Schneider, J., Lucena, J., & Leydens, J. A. (2009). Engineering to help. *IEEE Technology and Society Magazine, 28*(4), 42–48. doi:10.1109/MTS.2009.935008
Shapiro, J., & McNeish, J.-A. (2021). *Our extractive age: Expressions of violence and resistance*. Routledge.
Shelley, P. B. (1840). A defence of poetry. In M. Shelley (Ed.), *Essays, letters from Abroad, translations and fragments* (pp. 1–57). Edward Moxon.
Simonsen, J., & Robertson, T. (2013). *Routledge international handbook of participatory design*. Routledge.
Smith, J., Tran, A. L. H., & Compston, P. (2019). Review of humanitarian action and development engineering education programmes. *European Journal of Engineering Education, 45*(2), 249–272. doi:10.1080/03043797.2019.1623179
Timmermans, J., Blok, V., Braun, R., Wesselink, R., & Nielsen, R. Ø. (2020). Social labs as an inclusive methodology to implement and study social change: The case of responsible research and innovation. *Journal of Responsible Innovation, 7*(3), 410–426. doi:10.1080/23299460.2020.1787751
Vaneigem, R. (1983 (1967)). *The revolution of everyday life*. Left Bank Books and Rebel Press.
Varela, F. J. (1999). *Ethical know-how: Action, wisdom, and cognition*. Stanford University Press.
Virilio, P. (2007). *The Original Accident* (J. Rose, Trans.). Polity Press.
Walsh-Dilley, M. (2017). Theorizing reciprocity: Andean cooperation and the reproduction of community in highland bolivia. *The Journal of Latin American and Caribbean Anthropology, 22*(3), 514–535. doi:10.1111/jlca.12265
Winner, L. (1986). Do artifacts have politics? In L. Winner (Ed.), *The Whale and the reactor: A search for limits in an age of high technology* (pp. 19–39). Chicago University Press.
Woolgar, S., & Lezaun, J. (2013). The wrong bin bag: A turn to ontology in science and technology studies? *Social Studies of Science, 43*(3), 321–340. doi:10.1177/0306312713488820
Wright, E. O. (2010). *Envisioning real utopias*. Verso.