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knowledge generation in
South African Higher Education

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INTRODUCTION TO THE APPLICATION OF SOCIAL JUSTICE THEORIES IN ENERGY ENGINEERING EDUCATION FOR SOCIO- TECHNICAL DESIGN

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Introduction

South Africa is classified as one of the most unequal societies in the world, according to the Gini coefficient – a statistical method used to indicate the income or wealth distribution of a nation's working population as a proxy index to measure inequality (StatsSA, 2020). This index is a single number between 0-1; the higher the index, the greater the nation's degree of income inequality. In 2015, the Gini coefficient of South Africa was determined to be 0,65, showing that one-tenth of the population continued to earn more than half of the country's household income; the poorest one-fifth accounted for less than one-half per cent of the income in South Africa (StatsSA, 2020). A qualitative interpretation of the preceding findings is that the black majority population of South Africa live below the poverty threshold in informal settlements with few or no resources nor human capabilities that can propel them to a higher social level. Various social development intervention programmes are being rolled out and implemented to correct the injustices perpetrated by the previous apartheid government that segregated the country's development along the lines of racial demography (Merrino, 2020). According to the South African government, the National Development Plan (NDP) 2030, christened 'Our Future', is poised to lay the pathways to evenly develop society by sustaining existing developments and addressing the past apartheid government's injustices (RSA NPC, 2012).

The implementation of many energy engineering projects was meant to be a way to alleviate historical fair-access-to-energy injustices, yet has caused many social and environmental land injustices and health issues for the communities where these projects have been implemented. Lucena (2013) argues that many engineers are committed to an ideology of depoliticisation of engineering that leads them to draw a boundary around the technical content and leave the non-technical (for example, the social, the political) outside of

engineering. They believe that they do not need to learn about social justice because that is the purpose of the code of ethics. Unfortunately, many engineers continue to believe that meritocracy in engineering works well, that inequalities are just outcomes of a fair system, and that social justice due to its social nature does not belong to engineering's technical realms. Hollander (2010) argues that humanitarian engineering or socially responsible engineering was accepted by engineering bodies and large corporations, while social justice was a hotly contested topic. Social responsibility is a response from the engineering industry to the technological needs of the society, which, in other words, means it is driven by societal needs such as building a power plant in an area with increased energy demands. In contrast, social justice is a broader topic related to considering the impact that building such a power plant has on the life of the communities and the environment. Understanding social justice principles is quite a weighty topic that requires an established theoretical foundation to understand different social justice theories.

Understanding social justice theories are essential for engineering educators who incorporate social justice into their different academic endeavours. However, the different social justice theory principles could be considered vague and theoretical; it could be difficult to apply in engineering classrooms and laboratories. In other words, classroom discussion of social justice issues could be side-lined when competing with assessment imperatives, which students see as more important to their technical studies; or in most cases, because an engineering educator and students do not understand or value these concepts. Therefore, it is essential to create a community of conscience in which engineering students' views and prospects about their lives and communities are respected and appreciated, where topics of different social injustices on the table are freely discussed. Looking at engineering education, the voices of students coming from disadvantaged communities – lacking basic services such as electricity, water, roads, proper housing and an internet connection are important when one is teaching design and implementing engineering projects. Students' contribution, not only on what their communities need but also on how engineering projects negatively affect them, is an important tool to improve teaching and learning. Those students will combine core engineering skills such as problem-solving and accuracy with those needed to achieve a more just community, where engineering benefits the rich and takes care of the disadvantaged.

Leydens and Lucena (2018:80) lament and caution that, although engineers generally wish to help people and thereby advance the cause of social justice, their desire to help and complete projects can result in blind spots that translate into technical aspects of

engineering solutions given higher prominence while complementary, non-technical factors critical to social justice are relegated to a lesser position:

Not only can good engineering and social justice exist simultaneously, but it can be argued that the very definition of good engineering is taking into account social justice (Leydens & Lucena, 2018:94).

This argument for good engineering can also provide a basis for educating engineering students to commit to being a voice for their communities in the industry, mainly controlled by people representing classic engineering principles that limit ethics to the accuracy of design and implementation, without considering the rights of affected humans and non humans.

Leydens and Lucena (2018) explore the role of critical pedagogy in higher education by adopting a socio-technical design framework applied as a heuristic tool. The authors suggest that engineering educators must orientate their students proactively in the socio-technical aspects of engineering solutions. It is suggested here that social justice elements be incorporated into engineering design, an approach that serves to guide the applied solution. In this way, the solution ascertained should encompass a process that considers multiple viewpoints on its path to a derived conclusion.

The rest of this chapter is organised as follows:

- Section 2 discusses engineering education and socio-technical engineering design.
- Section 3 introduces two social justice theories, namely, Rawls's theory and posthumanism theory.
- Section 4 presents the application of the discussed theories to energy engineering education.
- Section 5 presents the chapter conclusions.

Engineering education and socio-technical engineering design

The governmental statutory body that regulates the engineering profession and training in South Africa, the Engineering Council of South Africa (ECSA), defines engineering as “the practice of science, engineering science and technology concerned with the solution of problems of economic importance and those essential to the progress of society” (ECSA, 2020). To encapsulate the social aspect of engineering practice requirements, it further includes that “solutions rely on analysis and synthesis, underpinned by sound techno-economic analysis. Solutions must take into account the needs of society, sustainability and the protection of the physical environment ...”. Three distinct aspects that require focus are the activities that will contribute to “economic, social or human needs” (ECSA, 2020). We believe the three aspects must be integrated to foster good engineering practice that will promote social justice, especially for previously-disadvantaged communities and those

underrepresented in South African demographics. Developing an engineering curriculum that will meet this requirement is not trivial.

The engineering education curriculum must educate future engineers to consider projects' technical design requirements and full impact from different perspectives. These perspectives include an ecological perspective, an intellectual property perspective, a business perspective, and a sociological perspective.

Riley (2018: xix), in her Foreword in *Engineering Justice*, posits that

... engineering education is presently mismatched with what is needed in engineering practice and does not prepare engineers to meet the responsibilities of the profession. Today's typical engineering students graduate ill-equipped to properly frame and define engineering problems and solution spaces, to adequately identify the benefits and constraints of engineering, *to holistically conceive of sustainability in their work, and to commit fully to dismantle power and privilege in an effort to foster diversity and inclusion* (Leydens & Lucena, 2018: xix) [authors' emphasis].

The *Washington Accord* is an international agreement between bodies responsible for accrediting engineering degree programmes, to which South Africa is a signatory through the statutory body of ECSA. ECSA Graduate Attribute (GA) 7 demands that graduate engineers “demonstrate knowledge and understanding of the impact of engineering activity on the society, economy, industrial and physical environment”. The relevant part of the range statement of Graduate Attribute 7 states:

The combination of social, workplace (industrial) and physical environmental factors is appropriate to the sub-discipline of the qualification. Evidence may include case studies typical of the technical practice situations in which the graduate is likely to participate. Issues and impacts to be addressed ... (ECSA, 2020) [authors' emphasis].

This chapter focusses on the sociological perspective using two theoretical social justice frameworks. The authors of this chapter believe that implicitly infusing social justice principles into project requirements of an engineering design will sensitise engineering students to consider

- the ecological implications of the site location;
- whom the project serve;
- how the project will be received, be looked after;
- what human resources could be employed from the local community;
- whom the project will benefit, and
- how the project will affect those living in the area and surrounding areas.

Importantly, this approach will encourage the use of indigenous knowledge in solving engineering problems contextualised to the people of a society or community. This stance is an appreciation of epistemic humility – a recognition that there are multiple ways of knowing. This approach will also make it easy for an accrediting engineering programme

body, such as ECSA, to assess this graduate attribute. An application exemplar is provided in a subsection of this chapter to illustrate how to implement this approach.

Applying the selected social justice theories will increase the appeal, applicability, relevance, and interest of engineering curricula for prospective students from diverse backgrounds by providing new discernibility to our time's salient socio-technical problems. To this end, students' retention and throughput will increase, leading to a higher return on investment in engineering education in South African higher learning institutions. Additionally, it will enable justice to be engineered using Socio-Technical Engineering Design (STED) criteria to create a more just world with engineers as change-agents of the society (Leydens, Lucena & Nieuwsma, 2014; Leydens & Lucena, 2014).

This chapter's guiding research question is how problem formulation for an engineering design project is constructed to attain crucial contextual understanding, skills and consciousness of structural conditions, and power relations to promote social justice, framed by posthumanist principles and social justice theory. With this in mind, we provide a set of criteria using posthumanism and social justice theory as theoretical frameworks for designing socio-technical engineering project dimensions as part of an engineering curriculum; easily assessable by aligning its outcomes with GA 7 and some related attributes of the *Washington Accord*. The infusion of social aspects enabled by the two abovementioned social theories of engineering design is operationalised by developing STED criteria.

Theoretical frameworks

Theory of Justice by John Rawls

In the historically skewed social system such as the current dispensation in South Africa, teachers and classrooms merely replicate and reinforce patterns of institutional, societal and epistemological inequalities and disparities in the higher education institution. Social justice theories have always tried to introduce multiple frameworks in which institutions and educators can work to achieve a more just educational system for their students.

A definition of social justice in education is succinctly termed:

Social justice-oriented approaches in education refer to standpoints and scholarly traditions that actively address the dynamics of oppression, privilege, and -isms, recognizing that society is the product of historically rooted, institutionally sanctioned stratification along socially constructed group lines that include race, class, gender, sexual orientation, and ability. Working for social justice in education means guiding students in socio-technical design of their socialization into this matrix of unequal relationships and its implications, analysis of the mechanisms of oppression, and the ability to challenge these hierarchies (Sensoy & DiAngelo, 2009:350).

There are different views of social justice. This section will focus on views of social justice as expressed by John Rawls' (1999) seminal work, culminating in the *Theory of Justice: Revised Edition* in which he describes his central theme of justice as fairness; in his social contract theory, justice is a virtue to be applied in social institutions. He further proposed two principles of justice: his 'first principle' of justice relates to equal liberty, which explains that all people are entitled to the same level of freedom, and his 'second principle' of justice, or the difference principle, addresses social and economic inequalities.

In Rawls's view, equal liberty is considered paramount, followed by equal or fair opportunity. As Thomas Pogge (2007) explains, the Rawlsian theory of justice started by criticising utilitarianism. Rawls (1999) explained that the aim of his theory of justice as fairness is to be an alternative to the strict classical utilitarian theory. Pogge (2007) explains that Rawls changed his investigation from the moral evaluation of behaviour and personality (ethics) to social institutions. Modern societies caused complex social problems which currently need institutional rather than interactional moral analysis. According to Pogge (2007), the scope of Rawls's theory is limited to six restrictions:

- Modern society.
- Modern society's members (only fully capable humans).
- Scarce goods (rights and liberties, educational and employment opportunities, income and wealth).
- Basic institutions (political, economic, legal, education and health care institutions).
- Ideal theory (how well each candidate's public criterion of justice would guide and organise human beings).
- Respect for individuals' diversity (moral, religious and philosophical).

Rawls's theory has two key concepts: the 'original position' and the 'veil of ignorance'. Rawls (1999) defines the 'original position' as the current condition in which any accords are fair. According to Pogge (2007), Rawls wanted to present a hypothetical-contract account that serves as an expository means for a notion of fairness. The original position is inspired by the established theory of 'social contract', where the intent is to use the concept of pure procedural justice as a foundation for the theory. Rawls emphasises that participants in the original position should be acquainted with the necessary broad-spectrum information that affects justice values: choosing from them or developing new principles. However, Rawls' 'veil of ignorance' principle states: "No one knows his situation in neither society nor his natural assets, and therefore no one is in a position to tailor principles to his advantage" (Rawls, 1999:121). Rawls modified the veil of ignorance principle to deal with the generational justice issue by adding the duty of saving for posterity. According to Pogge (2007), Rawls believes that community standards of justice have to be chosen from behind a 'thick' veil of ignorance. Thereafter, Pogge (2007:66) states: "Rawls is prepared gradually to lift the veil of ignorance, after his public criterion of justice has been chosen, to allow the

parties to specify this criterion further to adapt it to the conditions of a particular society". Rawls (1999) proposed two basic principles for social justice:

- The first principle is to maintain fundamental rights and liberties for all society members.
- The second principle is the opportunity and difference principle.

Catherine Beattie (1982) mentions that Rawls's theory confirms that a fair distribution of resources would improve different community members' abilities. These resources could be education, energy, or water, to mention a few. For example, the unfair distribution of educational resources can currently be seen today with the spread of the Covid-19 pandemic. Some of our engineering students cannot access online resources and cannot participate in virtual laboratory activities due to poor infrastructure or lack of financial resources. To this extent, one can understand the need for Rawls's principles (Shields, 2015) which offer educational institutions design guidance and assessment to avoid injustice, when some have greater advantages than others by at least some arbitrary factors, such as race, gender or social class.

Critical posthumanism also uses concepts of social justice, and these could be brought together rather than separated. In the following section, a thorough discussion of posthumanism is presented.

Critical posthumanism by Rosi Braidotti

Critical posthumanism is a theory composed of philosophical positions which can be considered transdisciplinary. The expression 'posthumanism' started in modern critical discourse in the humanities and social sciences during the mid-nineties, while its genesis dates back to the sixties (Wolfe, 2010). In a 2012 review of Wolfe's book, *What is Posthumanism?* Crary (2012) explains that Wolfe (2010) aimed to authenticate and expand the composite yet consistent idea, identified as 'posthumanism', as a contrasting idea to classic humanism. In classic humanism, human beings are characterised as distinctive by their possession of abilities of reason that partly differentiate them from other forms of life. Taylor and Hughes (2016) explain that posthumanism questions the fundamental duality between human and non-human on which humanist theory is founded, along with the categories and identities it emphasises. Posthumanist research practices offer new ethics of engagement by including the non-human. In her book, *The Posthuman*, Braidotti (2013:13) argues that critical posthumanist philosophy provides an alternative view of the world in contrast to humanism. This European civilisation model promotes the Western philosophy of 'human' and is represented by the Vitruvian Man designed by Da Vinci, circa 1490. Braidotti suggests that the humanist view promotes the idea of human superiority and dominion at the expense or detriment of any other. Posthumanism critiques anthropocentrism, or the view of the human's centrality as the measure of all things.

Ferrando (2019:1) describes ‘posthumanism’ as an encompassing term that includes the many and various instances of common characteristics such as philosophical, cultural and critical posthumanism; transhumanism; new materialisms through feminist themes; and posthumanities, with antihumanism, metahumanism and metahumanities as a broader backdrop. Posthumanism seeks to challenge the world’s binary view offered by a humanism that presents entities as compartmentalised and disconnected. Examples of such binary views include male/female, black/white or human/non-human. Humanism imposes a superiority on one entity, human, to the detriment or disadvantage of the other, the non-human. Humanism focusses on the differences between these entities and presents them as negative or undesirable:

- The eminent entity is represented as the measured standard, while the opposing entity is portrayed as lacking or deficient.
- The binary is manifested in the belief that human needs and desires outweigh those of the other, the non-humans.

The interests of the other are reduced and relegated to a lesser status than those of the human.

In her book, *The posthuman*, Braidotti (2013a) argues that the posthuman provides a more inclusive version of difference that addresses our many adaptable identities. Braidotti outlines new forms of a holistic philosophy that emerge from the array of race studies, environmentalism and gender studies. For the posthuman, opportunities exist in rising to the challenge and recognising an affirmative social contract in parallel with a positive contribution to a sustainable environment. In *The posthuman*, Braidotti (2018) argues for the need to see ourselves as related and connected to the world with a form of ethics that utilises a relational view:

A posthuman ethics for a non-unitary subject proposes an enlarged sense of inter-connection between self and others, including the non-human or ‘earth’ others, by removing the obstacle of self-centred individualism (Braidotti, 2013a:49).

Critical posthumanism portrays humans as inseparable from and interwoven with the world they inhabit. Humans are not isolated and unaffected entities but are dependent and reliant on this connection. If the environment surrounding the human is healthy and thriving, then it translates that human welfare similarly thrives. In her book, *Posthuman knowledge*, Braidotti (2019:140) expands her view on the relational aspect of critical posthumanism that encompasses not only human but non-human interests:

Posthuman knowledge engages its relational capacity in order to produce adequate understandings of the interconnection with all matter. It does so at a historical time when science and technology have revolutionised knowledge of matter in a multi-scale manner. The pursuit of adequate knowledge needs to stay attuned to and work in tandem with the ethical pursuit of the power to act in transversal alliances with human and non-human actors.

Braidotti offers a means for education to adopt posthuman principles through the notion of a ‘posthuman university’. This entails the adoption of an inclusive and encompassing vision of education practices and their effects. For engineering education, the adoption of a relational ethic would allow engineers to be mindful of applying their theory and systems in the world. Braidotti presents a view of posthuman education that seeks to create and foster an awareness of the ‘connected’ and intertwined nature of the world: “Posthuman critical thinkers and educators situate themselves in and as part of the world, defending an idea of knowledge production as embedded, embodied, affective and relational” (Braidotti, 2019: 254).

In Braidotti’s vision of a posthuman university, both teachers and students need to be aware of the effect that their practices and enactments have on and in the world in which they operate: “The relational model of subjectivity concretely means that it is advisable to make alliances in a transdisciplinary and multidirectional manner, both within and without the academic institutions” (Braidotti, 2019:145).

The posthuman university also motivates a new inclusive model for academia where there is value envisioned for an interdisciplinary cohesiveness in academia. The adoption of interconnected disciplines can benefit from a new ethical practice:

The core value is that we need to organize academic communities that reflect and enhance an ethically empowering vision of the posthuman subject of knowledge. Transversal interconnections across the disciplines and society [are] the way to implement an ethical praxis that aims to cultivate and compose this new collective subject. This subject is an assemblage – ‘we’ – that is a mix of humans to non-humans, zoe/geo/techno-bound computational networks and earthlings, linked in a vital interconnection that is smart and self-organizing, but not chaotic (Braidotti, 2019:152).

In the current model of academia, the university is challenged to forego viewing learning as a commodity and adopt collaborative knowledge that advocates social cohesion and responsible citizenship:

Posthuman university structures of knowledge production run against the spirit of contemporary identity-loaded, consumerist capitalism and its commodification of Life itself. They favour instead non-profit experimentations with how many ‘we’ – collective transversal subjects – can be currently assembled on multiple planetary locations and what ‘we’ are capable of becoming (Braidotti, 2019:152-153).

Braidotti (2013b) believes that critical posthumanism can assist in producing socially relevant knowledge

that is attuned to basic principles of social justice, the respect for human decency and diversity, the rejection of false universalisms; the affirmation of the positivity of difference; the principles of academic freedom, anti-racism, openness to others.

Braidotti (2013a:5) explains that:

Critical posthumanism theory can be utilized as both a genealogical and navigational tool, or more specifically it can be used as a generative tool to help us re-think the basic unit of reference for the human in the bio-genetic age known as 'Anthropocene'.

Engineering education could benefit from integrating posthumanist philosophy that positions educators and students to critically view the impact of their 'engineering' actions in the world. The fundamentals of critical posthumanism's new engagement ethics, as Radomska (2010) describes, are overcoming humanist anthropocentrism, taking into account the non-human others and affirming difference. Ulmer (2017:2) suggests that "justice involves more than what can be found solely within the realm of human relations. Rather, justice is also material, ecological, geographical, geological, geopolitical, and geo-philosophical". Consequently,

as humans become more entangled in intricate relationships with technology and science, with other animals and the environment, notions of the human, along with various humanisms and anthropocentric approaches, have become difficult to uphold (Åsberg, Koobak & Johnson, 2011:11).

An application of these introduced social theories and their principles are presented in the next section.

Application in energy engineering education

The previous section's discussion revealed the two social justice theories' origin, foundation and basic principles. It can be concluded that these two theories on social justice have a complementary nature, based on the discussions about their standpoints. Rawls, a liberal democrat, has a very humanist view of social justice, while Braidotti has an ecological view.

In this section, these two theories' main principles are condensed to be precise and applicable to engineering educators and students with no formal sociology background. At this stage, the intention is to relate them to energy engineering education as an example to be followed by other engineering disciplines.

Rawls' theory of justice as fairness can be used in energy engineering education by applying its main concepts. The first concept, the 'original position', can be applied to create a proposed agreement among different parties or stakeholders involved in energy engineering projects: the engineers, the corporations and local communities. This agreement should answer how energy engineers can maintain civil liberties; open up more opportunities, make fair use of natural resources; enhance human abilities; diminish harm and threats to humans and the environment. Thereafter, this agreement will create productive conversations that allow engineering students to share their ideas and respond to others' ideas about their views concerning social justice in the design subject. Educators could provide questions that guide

thoughtful and rich conversation while avoiding the ones that could shut down discussion. The second principle, the ‘veil of ignorance’, means that the service receiver or consumer’s race, class, and other demographics are not considered when applied to energy engineering education. Everyone has an equal chance of accessing that essential product, energy.

In applying posthumanist principles to an engineering problem, the exercise should enlighten and enliven the engineer to consider the effect that engineering solutions have in the world. Here we expand on two posthumanist principles: relational capacity and posthuman ethics.

- When an energy engineering solution is proposed for a particular area, what biases are realised?
- What power relations are at play?

These considerations lay bare the underlying and sometimes hidden agendas if not explicitly addressed upfront. Engineers wish to solve technical problems, but this desire, if not guided by socio-technical design considerations, could be misguided and ineffective.

- Does the proposed engineering solution only reflect the position of the engineer?
- Are the views of other affected entities incorporated in the engineering solution?
- Have the interpretations of affected communities and other stakeholders been included and acknowledged?

Incorporating multiple opinions acknowledges possible biases and power relations. The acquisition of a relational capacity should make an engineer aware of other affected entities’ concerns and encompass them in the engineering solution. In congruence with the relational capacity:

- What environment will the engineering solution affect? How will this effect be manifested?
- Privilege is given to entities that can voice their concerns, but what consideration is given to entities devoid of this capability?

Incorporating the concerns of humans and also those of non-human entities is the posthuman ethics principle.

These questions and considerations are new to engineers and engineering educators, and for engineering solutions and their applications to be effective and impactful, they should be part of the engineer’s socio-technical design toolbox. In Table 3.1, the social justice principles based on the two theories are presented to energy engineering students to guide them through a design problem that considers the context and the social impacts of their design.

TABLE 3.1 Social justice heuristic as a socio-technical design framework.

Social justice principles	Guiding questions
Original position	How is your socio-technical engineering solution able to contribute to civil liberties, open more opportunities and a fair share of resources and opportunities? How is your socio-technical engineering solution able to enhance human capabilities? How are the ideas of the community taken into consideration in offering your socio-technical engineering solution?
Veil of ignorance	How is your socio-technical engineering able to ensure that everyone has an equal chance of accessing your socio-technical engineering solution? How is access to your socio-technical engineering solution independent of class, race and other demographics? Does the proposed socio-technical solution allow productive and open conversation amongst community members to be incorporated into the proposed solution?
Relational capacity	What power relations are at play in arriving at your socio-technical engineering solution? What socio-technical engineering-design biases are present in your socio-technical engineering solution? How does your offered socio-technical engineering solution reflect your predisposed position? Are the views of other entities reflected in your socio-technical engineering solution?
Posthuman ethics	How are the non-human components, such as the environment, affected? How do you propose to mitigate these environmental effects? How is your socio-technical engineering solution able to diminish threats and harms to both humans and the environment?

For example, at the honours study level specialising in energy engineering, students must design a solar photovoltaic or wind farm for a rural community. They must take care of the technical aspects of the load demand and the sizing of their energy systems’ components and consider various social justice aspects, based on Table 3.1, used as guidelines for their design process. The students would have to consider:

- Their design’s accuracy and benefit to the engineering company that builds and sells energy to consumers.
- The wellbeing of the humans who are the main consumers.
- The animals, plants and overall environment in the area of concern.

They would have to consider if these factors would be affected by the built of the energy system and other electrical and electronic components, and the land issues about the solar or wind farm's location. As an illustration of this socio-technical design criterion, for the energy technologies adopted, there would be the question of whether their end-of-life impacts have been considered. The product life cycle requires consideration of the disposal or replacement of parts. A question for solar panels and wind turbines would be whether sustainable disposal methods have been incorporated to minimise the impact on affected entities. These considerations are pertinent for developing economies with limited guidelines and regulations pertaining to sustainable disposal and recycling methods. In the end, their design will consider both the social and technical aspects of the project.

Conclusion

This chapter has introduced a new approach to engineering design. The socio-technical approach contrasts with the previously adopted traditional methods that consider the technical solution supreme and relegate non-technical applications to a lower rank of importance. The authors have demonstrated that to move knowledge beyond the black and white of a derived solution, the many colours and avenues of knowledge that more practically reflect real-world scenarios must be explored. Students and educators need to be aware that real engineering solutions require a critical discourse in their implementation.

We have attempted to start a conversation on developing, integrating and implementing social justice criteria into the South African engineering curriculum by providing socio-technical engineering solutions in an engineering design subject. This approach will influence engineering students' education to respond to and make amends in addressing and redressing the previous apartheid government's injustices that skewed social development programmes along racial demographic lines. There exist many social justice theories, but only two are adopted and implemented in this chapter (Rawls' theory of justice and the posthumanism theory) as a foundation to develop a socio-technical engineering solution procedure for a chosen application in an engineering curriculum; an application to energy engineering education was made. The four social justice principles presented can be conferred to energy engineering educators and students to guide them through the formulation and solution of a design problem that considers their design's context and social impacts.

The approach used is general and can be used by other researchers and engineering educators, employing various social theories to promote engineering students' social responsibility towards the communities and environments where their projects are implemented. It is expected that this seemingly controversial approach will generate many

robust discussions, arguments and debates among engineering professionals, engineering students and engineering educators that will further develop this initiative.

References

- Åsberg, C., Koobak, R. & Johnson, E. 2011. Beyond the humanist imagination. *NORA – Nordic Journal of Feminist and Gender Research*, 19(4):218-230. <https://doi.org/10.1080/08038740.2011.625042>
- Beattie, C. 1982. Rawls and the distribution of education. *Canadian Journal of Education / Revue canadienne de l'éducation*, 7(3):39. <https://doi.org/10.2307/1494694>
- Braidotti, R. 2013a. *The posthuman*. Cambridge: Polity Press.
- Braidotti, R. 2013b. Posthuman humanities. *European Educational Research Journal*, 12(1). <https://doi.org/10.2304/eeer.2013.12.1.1>
- Braidotti, R. 2019. *Posthuman knowledge*. Cambridge: Polity Press.
- Crary, A. 2012. Review: What is posthumanism? By Cary Wolfe. *Hypatia, Special Issue: Animal Others*, 27(3):678-685. <https://doi.org/10.1111/j.1527-2001.2012.01268.x>
- ECSA (Engineering Council of South Africa). 2020. *What is engineering?* ECSA: Engineering in South Africa. <https://www.ecsa.co.za/engineeringsa/SitePages/What%20is%20Engineering.aspx> [Accessed 24 April 2020].
- Ferrando, F. 2019. *Philosophical posthumanism*. London: Bloomsbury Academic. <https://doi.org/10.5040/9781350059511>
- Hollander, R. 2010. R. Hollander Opening Remarks. *APPE Mini-Conference: Engineering towards a More Just and Sustainable World, Cincinnati, Ohio, March 6 – 7, 2010*. <https://www.nae.edu/-/4/18753/APPE-2010-MiniConference-Resources-> [Accessed 24 April 2020].
- Leydens, A., Lucena, J. & Nieusma, D. 2014. What is design for social justice? Paper presented at ASEE Annual Conference and Exposition, Indianapolis, 15-18 June. 1-25.
- Leydens, J.A. & Lucena, J.C. 2014. Social Justice: A missing, unelaborated dimension in humanitarian engineering and learning through service. *International Journal for Service Learning in Engineering, Humanitarian Engineering and Social Entrepreneurship*, 9(2):1-28. <https://doi.org/10.24908/ijlsle.v9i2.5447>
- Leydens, J.A. & Lucena, J.C. 2018. *Engineering Justice: Transforming engineering education and practice*. Hoboken, NJ: Wiley-IEEE Press (Institute of Electronic and Electrical Engineers). <https://doi.org/10.1002/9781118757369>
- Lucena, J. 2013. Introduction. In: J. Lucena (ed). Engineering education for social justice: Critical exploration and opportunities. *Technology and Culture*, 10. New York, NY: Springer. https://doi.org/10.1007/978-94-007-6350-0_1
- Merrino, S. 2020. *Measuring labour earnings inequality in post-apartheid South Africa*. WIDER Working Paper 2020/32. Helsinki: United Nations University World Institute for Development Economics Research (UNU-WIDER). <https://doi.org/10.35188/UNU-WIDER/2020/789-7>
- Pogge, T. 2007. *John Rawls, his life and theory of justice*. Oxford: Oxford University Press. <https://doi.org/10.1093/acprof:oso/9780195136364.001.0001>
- RSA NPC (Republic of South Africa. National Planning Commission). 2012. *National Development Plan 2030. Our future – make it work*. http://www.dac.gov.za/sites/default/files/NDP%202030%20-%20Our%20future%20-%20make%20it%20work_0.pdf [Accessed 5 May 2020].
- Radomska, M. 2010. Towards a posthuman collective: Ontology, epistemology and ethics. *Praktyka Teoretyczna*, 1(1):93-115. https://www.academia.edu/513218/Towards_a_Posthuman_Collective_Ontology_Epistemology_and_Ethics

- Rawls, J. 1999. *A theory of justice: Revised Edition*. Cambridge, MA: Belknap Press of Harvard University Press.
- Riley, D.M. 2018. Foreword. In: J.A. Leydens & J.C. Lucena (eds). *Engineering Justice: Transforming engineering education and practice*. Hoboken, NJ: Wiley-IEEE Press (Institute of Electronic and Electrical Engineers).
- Sensoy, Ö. & DiAngelo, R. 2009. Developing social justice literacy: An open letter to our faculty colleagues. *Phi Delta Kappan*, 90(5):345-352. <https://doi.org/10.1177/003172170909000508>
- Shields, L. 2015. From Rawlsian autonomy to sufficient opportunity in education. *Politics, Philosophy & Economics*, 14(1):3-66. <https://doi.org/10.1177/1470594X13505413>
- StatsSA (Statistics South Africa). 2020. *How unequal is South Africa?* StatsSA. <http://www.statssa.gov.za/?p=12930> [Accessed 11 May 2020].
- Taylor, C.A. & Hughes, C. (eds). 2016. *Posthuman research practices in education*. 1st Edition. New York: Palgrave MacMillan. <https://doi.org/10.1057/9781137453082>
- Ulmer, J. B. (2017). Posthumanism as research methodology: inquiry in the Anthropocene. *International Journal of Qualitative Studies in Education*, 30(9), 832-848. <https://doi.org/10.1080/09518398.2017.1336806>
- Wolfe, C. 2010. *What is posthumanism?* Minneapolis, MN: University of Minnesota Press.