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Taking Curriculum Reform To The Next Level: The Need For Decolonising Work In Engineering Education

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ABSTRACT

As humanity is faced with unparalleled challenges, from the climate emergency to rising inequality, there is a renewed emphasis on the role of engineering professionals to contribute solutions to global problems. However, there is increasing recognition that the way that engineers are trained through higher education is inadequate to prepare them to address these grand challenges. This paper aims to deepen theoretical perspectives on why the engineering education status quo is falling short. Taking a British perspective, I outline how the epistemology and cultural ideologies, or the "episteme," of engineering continues to shape our discourses within modern day engineering education, and constrain our ways of knowing, thinking, being, and acting. I will present data from a critical ethnography to reveal how discourses of engineering continue to be steeped in coloniality and perpetuate Western, modernist narratives for the need for growth and technologically-driven development. I aim to demonstrate that approaches to curricular reform will continue to fall short without concerted efforts to decolonise our ways of knowing and doing in engineering. Finally, I provide some suggestions on pathways forward.

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1 INTRODUCTION

1.1 The engineering status quo

Engineers have been responsible for the development of some of the most consequential and widespread technological innovations in human history (Amadei 2014; Downey 2014). From water sanitation systems to refrigeration to mobile phones to trains and cars and airplanes, the vast impacts of engineers on the world in which we live are undeniable. As we as a society are faced with unparalleled challenges, from the climate emergency to rising inequality to Western political destabilization, there is a renewed emphasis on the role of engineering professionals to contribute solutions to global problems.

However, it is crucial to recognize that engineering innovations and interventions have not necessarily always led to positive or beneficial change for all (Clemence 2020). High profile engineering disasters - from the Bhopal disaster to the Grenfell tower fire – are some of the more obvious indicators of a disconnectedness between engineering and society. Yet, while these high-profile examples may increase the public salience of the precarity of engineering products and structures, it is the less obvious examples that shed light on the more insidious and subverted nature of engineers' lack of connectedness to broader social accountability. Bugliarello (1991) offers the following provocation:

> "Would the societal consequences have been different if engineers had been more involved in a systematic study of engineering's complex role in society, had a working dialogue with social scientists, and had better communication with the public? For instance, could we have anticipated that the automobile would turn out to be a severe source of pollution as well as a powerful instrument of urban change [or] that radios in every household would catalyse the political emancipation of women…?" (74).

Answering these questions requires nuanced, multi-level political, ethical, and social conversations which involve engineers. However, "the voice of engineers in the discussion of engineering's social role has been weak, episodical, and often self-centred" (Bugliarello 1991).

1.2 Cultural formation of engineers

As the previous examples demonstrate, the ways in which engineers view themselves in relation to the wider world, and the ways in which they act and apply their engineering knowledge are not neutral or consequence free. Then how is it we have a profession like engineering that is so vital to us as a society, yet consistently misunderstands or eschews crucial aspects of its social responsibility?

Engineering, like other professions, is not just a collection of knowledge, skills, and practices grouped into a set of jobs. Professions have rich and historically rooted cultures that are built into and around their knowledge, skills, and practices" (Cech and Sherick 2015). Using Foucault's concept of episteme, the following exploration delves into the historical foundations of modern-day engineering in the UK. According to Foucault, an episteme "delimits in the totality of experience a field of

knowledge, defines the mode of being of the objects that appear in that field, provides man's everyday perception with theoretical powers, and defines the conditions in which he can sustain a discourse about things that is recognized to be true" (Foucault 1970). Bevir (1999) suggests that "although epistemes are rarely held consciously, they exercise an all-pervasive influence, saturating all of the religious, philosophical, scientific, social, and artistic thought and practice of an age" (Bevir 1999). Said in another way, an episteme is a culturally and historically constructed boundary condition that frames knowledge and understanding of the world. In his later work on "genealogy," Foucault incorporates the concept of power in his analysis of knowledge formation. Genealogical analysis aims, in part, to uncover the way that power relations form and are perpetuated through history by illuminating their role in serving specific social agendas (Foucault 1980).

If we acknowledge that the formation of engineering culture occurred through a historical trajectory and served particular social agendas, then it is important to spend some time understanding critical moments in the formation of modern engineering culture. Downey and Lucena suggest that "the identity of the engineer" emerged during the Enlightenment period (Downey and Lucena 2005). The episteme of the British engineer, therefore, must be understood through the lens of this historical period.

In the United Kingdom, the Enlightenment period intersects with British imperialism and colonisation. In fact, the Enlightenment ideal of progress was fuel for empire building. This particular notion of progress was undergirded by positivism, a philosophic position which emerged during the Enlightenment era in Europe, as a move to "cleanse men's minds of mysticism, superstition, and other forms of pseudo-knowledge" (Schön 1983). Positivism rests on the assumption that there is an objective truth, and it is possible to uncover that truth through the theory and methods of science (Denzin and Lincoln 2008).

British imperialism highly valued technical knowledge, quantitative data, and positivistic ways of knowing, putting engineers at the centre of social and political goals of the age. A brief history of this context is provided in the following section.

1.3 Engineering and capitalist colonial expansion

Throughout the 18th and 19th centuries, a new form of imperialism was on the rise, in the form of Western capitalist colonial expansion. Colonisation is defined by Loomba (2002) as the "conquest and control of other people's land and goods" (2). The process of colonisation has meant "unforming or re-forming" existing communities by colonizers, using a wide range of practices, including "trade, plunder, negotiation, warfare, genocide, enslavement and rebellions" (Loomba 2002). European empires were not the first to expand imperial might or establish colonies abroad. But the form of imperial expansion advanced by European powers, including the United Kingdom, was distinct. "Never before had one civilization overwhelmed all the others and set them on an entirely new course" (Headrick 1988, 4).

“Modern colonialism did more than extract tribute, goods and wealth from the countries that it conquered - it re-structured the economies of the latter…so that there was a flow of human and natural resources between colonised and colonial countries” (Loomba 2002, 3). One aspect of “re-structuring” new colonies involved transforming non-capitalist economies into those that could be exploited by European capitalistic interests. “This allows us to understand modern European colonialism ...as an integral part of capitalist development” (Loomba 2002, 20).

The “physical and material dimensions” of this new form of imperial expansion were advanced through the vehicle of engineering and technological innovation. Engineers were heavily involved in the construction of colonial infrastructure that facilitated extraction (Lucena 2015). Technological innovation and invention, such as steamships, and improvements in firearms and railways, increased the speed and efficiency, and decreased the cost, of colonial expansion into African and Asian territories. Technology was developed by Western engineers and scientists, for the benefit of the West, and “with scant regard for their long-range impact on the tropics.” (Headrick 1988, 7).

It was through their labour that engineers served the interests of imperial governments in building out their empires. By helping to “permanently transform” the structure of life in colonies throughout this time, engineers, whether consciously or not, participated and became complicit in the rise of capitalist colonialism (Loomba 2002; Lucena, Schneider, and Leydens 2010; Lucena and Schneider 2008).

This relationship is not over. It has been argued that the historic alignment between engineering, colonisation and capitalistic interests has not radically changed since the colonial age (Conlon 2019; Lucena, Schneider, and Leydens 2010; Slaton 2015). Some attest that that the colonial era never really ended, it just evolved into new forms of extraction and dehumanization, with engineers continuing to play a pivotal role in these systems (Boisselle 2016; Dei and Kempf 2006; Smith 1999).

The case of sea defence infrastructure in Guyana is a modern example illustrating the persistent effects of an entrenched colonial regime. Mullenite (2019; 2018) critically examined the social and political ramifications of colonial and postcolonial flood remediation projects in Guyana through genealogical analysis. During the colonial era, British colonialists infiltrated and gained increasing control over daily life through the construction and management of sea defence infrastructure. This strategy was extended by the postcolonial Guyanese regime, using “infrastructural commitments to maintain and grow their economic and political power” (Mullenite 2018, 187). Though the British regime formally ended in 1966, it is only recently that the Guyanese have begun reviving nature-based, indigenous sea defence solutions, such as regrowth of mangrove forests (175). This work highlights how a technological approach to flood management embedded a capitalist, colonial politic, an approach that has persisted into the present day.

2 METHODOLOGY

2.1 Methods

Escobar argues that “we need to anthropologize the West” (Rabinow, 1986, as cited in Escobar 2011, 11). This paper forms some contributions to that project. Results and discussion are drawn from a larger critical ethnography of an engineering department within a British HEI, with field work taking place in 2018-2019. The broader study focused on the first year of a new engineering MSc programme in engineering management for sustainable international development. Primary data collection methods involved participant observation, ethnographic and semi-structured interviewing, and reflexive journaling. Key informants/participants involved staff and students involved with the course, as well as key community partners involved with student projects. All key participants gave their informed consent. Any names mentioned in the analysis are pseudonyms.

2.2 Analysing discourses

In the following paper, I focus my analysis on discourse. In ethnography, identifying discourses through observed language acts serves as an important way of uncovering symbolic meaning. However, the degree to which ethnographers use and analyse discourses varies. In critical ethnography, this work can serve an important function in helping draw connections between micro-level empirical data and macro-level social and cultural conditions (Carspecken 2013; Davies 2012).

Discourse is a social process related to the way we use language. It is more than the exchange of content in a conversation, or the grammatical systems of syntax and morphology that make up common language. Rather, understanding language use as discourse acknowledges the impact that language has in shaping our world. Discourse allows us to know things, “to do things” and “to be things” (Gee 2004). Fairclough (1992) describes discourse as “a practice not just of representing the world, but of signifying the world, constituting and constructing the world in meaning” (64).

Foucault is credited with showing how discourse analysis can be used to deepen our understanding of the mechanisms of power in society. Foucauldian discourse analysis has become a critical tool for studying coloniality.

> “Discourse analysis...makes it possible to trace connections between the visible and the hidden, the dominant and the marginalised, ideas and institutions. It allows us to see how power works through language, literature, culture and the institutions which regulate our daily lives” (Loomba 2002, 47).

In the current study, there were many incidences throughout my fieldwork where I observed uses of terminology that appeared to uphold colonising representations of relations between British and sub-Saharan African nations. In the following sections, I connect ethnographic observations of language acts and with established theory on colonial discourses to draw some tentative conclusions about the ways in which participants contributed to the reproduction of colonial relations. I draw on Escobar’s analysis of development “as a regime of representation” that has established and

maintained Western conceptions of developed vs. developing and First vs. Third World (Escobar 2011). I aim to highlight how “stereotypes, images, and ‘knowledge’ of colonial subjects and cultures tie in with institutions of economic, administrative...control” (Loomba 2002, 54). I do so by drawing connections between the structure and content of the MSc course, the ways in which students, staff, and community partners relate to one another, and the discourses of development and coloniality.

3 COLONIAL LANGUAGE ACTS OBSERVED

3.1 Supremacy of imperialistic capitalism through development discourses

The terms “sustainable development” and “international development” have become commonplace across Western higher education institutions. Their inclusion in the names of courses of study, volunteer abroad excursions, and student societies signal opportunities for students to “do good” and to “help.” Alexander (Alexander 2012) contends, however, that terms like sustainable development have become “potent but empty rallying cr[ies], laden with positive value but so variable in content that [they are] almost devoid of meaning, other than being a Good Thing.” In an engineering context, these terms, especially sustainability and sustainable development, have come to mean something about the environment, but rarely connect to issues of society. Taken further, by applying an anti-colonial lens, we can start to see that “sustainable” or “international development” may not just be innocuous “good things,” but may have more insidious, colonial roots.

In Encountering Development, Arturo Escobar applied discourse analysis to the concept of “development” within the context of colonisation. In his analysis, he demonstrates how “development has relied exclusively on one knowledge system, namely, the modern Western one” (13). Escobar shows how “the dominance of this knowledge system has dictated the marginalization and disqualification of non-Western knowledge systems” (13).

Most telling of how the concept of “development” is used as a tool for maintaining colonial power relations is the story of how the term has been applied in the post war era. Though the concept of development is not new, the way that “sustainable development” and “international development” are used today emerged in the mid-1900s. During this time, a group of “so-called modern states (primarily Western European [countries] and the United States, and later Canada and Japan) created institutions (such as the International Development Association and UNESCO)” and convened panels of “experts” to “learn about, support, and improve life…in so-called developing states” (Kendall, 2009). An effect of this process was the construction of a new underclass of people in newly independent nations of the global south – “the poor” (Escobar 2011; Kendall 2009). Prior to this, the poverty of “natives” was not a great concern of colonizing nations. The general belief was that “even if the ‘natives’ could be somewhat enlightened by the presence of the colonizer, not much could be done about their poverty because their economic development was pointless. The

natives' capacity for science and technology, the basis for economic progress was seen as nil" (Escobar, 2011, 22).

The change in the Western conception of poverty "occurred…first with the emergence of capitalism in Europe and subsequently with the advent of development in the Third World." The invention of Third World poverty came the notion that "the poor" were "a social problem requiring new ways of intervention in society" (Escobar, 2011, p. 22). This new social problem required mechanisms and indicators of progress, which have been set by Western development institutions, and have largely focused on economic measures, such as Gross Domestic Product (GDP) per capita, job creation and growth, and access to modern technology, such as hospitals or electricity (Kendall 2009).

Though there have been many challenges to this econo-centric position, none have been powerful enough to shift the discourse of development beyond it or consider what alternative indicators of human progress could be. "The relative stability of the term 'development' reflects continued general agreement amongst powerful actors and institutions around the world on the shape and scope of the international development arena" (Kendall, 2009, 420).

Western higher education institutions are embedded within these global power relations and are part of the mechanisms that reproduce them. It was during the formation of institutions like UNESCO that concerns about the development of the Global South became salient to the field of education. UNESCO itself took up the mantle of education for development with the organisation of regional education meetings. There was a concurrent rise in other education-related professional bodies and institutions, including the US-based Comparative Education Society (Kendall, 2009). Over the past 70 years since, Western institutions of higher education took up the mantle of researching and developing pedagogy focusing on the "problem" of "the poor" in the "Third World."

Engineers have also been involved in development interventions since the inception of Western development institutions. Naturally, the transfer of technology, a key component of colonial and neo-colonial strategy and discourses, has relied on engineers' involvement. However, from the colonial to the neo-colonial era, ideologies around "natives'" need for science and technology morphed. From the belief that Africans were devoid of scientific thinking and technology, emerged the creation of the concept of the "Third World" and the necessity of its development. "In 1948, a well-known UN official expressed this … in the following way: 'I still think that human progress depends on the development and application of the greatest possible extent of scientific research. . . . The development of a country depends primarily on a material factor: first, the knowledge, and then the exploitation of all its natural resources'" (Escobar, 2011, 35).

Though engineers have been involved in the practices and discourses of development for centuries, "they never scaled up to make inroads in ...engineering education or in the mainstream professional conduct of engineers until [recently]"

(Schneider et al., 2009, 44). This shift has occurred, in part, as engineering interventions in the “Third World” focused on providing technical assistance and “appropriate technologies” to “communities” (44). “Engineering to Help” initiatives have made an appearance in Western higher education institutions, through organisations like Engineers Without Borders and Engineers for a Sustainable World (Schneider, Lucena, and Leydens 2009). There has been a concurrent increase in the number of programmes and courses of study in engineering higher education institutions.

3.2 Development discourses identified within the MSc course

There were a number of development discourses identified within the larger study of the engineering management for sustainable international development MSc. For the purposes of this paper, I will focus on two examples: discourses identified within taught modules, and within students’ conceptions of their work.

Community Engagement was one taught module within the MSc, delivered by an external educational partner. The module aims of Community Development were articulated to the students as follows:

> **Module Aims:** In the last 50 years community groups have demanded and increasingly been offered an important role in planning and designing new developments and large scale engineering projects. Today, in an environment of localism and nimbyism, with local residents increasingly seen as ‘experts’ in their own right, community engagement has become a crucial part of any development process. The module will introduce the role and importance of engaging communities, teaching various techniques of consultation and engagement, placed in a framework from top-down to bottom-up. These techniques will be placed against a range of critiques of engagement that have emerged in recent years, from the accusation that engagement silences, co-opts or manipulates local people. The module will include evolving examples of engagement such as the ‘charrette’, ‘Enquiry by Design’ and others, and will include a practical project in which students take part in engagement exercises.

In this descriptor, there is the implication of asymmetrical power relations between “community groups” and an invisible narrator. If community groups have been demanding and increasingly offered a role in planning and designing new engineering projects, who have they been demanding this from? We can infer the invisible narrator may be someone who has traditionally held power over the entire process of development. This person or group likely is from the West and has expertise in engineering. By situating this invisible narrator in the context of a module descriptor, students reading this text can easily step into the shoes of the invisible narrator, becoming the expert who holds the reins of power, controlling the nature and extent of engagement with “local people.” The lecturers who represent those who have been in power to decide on the course of development on behalf of “community groups” for centuries, are once again reinforcing these power relations, and training a new generation to take up their mantel.

Another module, Introduction to Development Studies, establishes the social and political context that the students would be working within. During one of the module sessions, I noticed that the conversation was rooted within Western discourses of development. The British and European staff and students on the course seemed very comfortable within this discourse and dominated the conversations.

> *Back in Anders' Monday lecture. I noticed this the last time I was here, too, but the way that Anders and some of the white, European students talk about SSA [sub-Saharan Africa] and other developing nations is very "othering." Not only do they dominate the dialogue in the classroom (frequency of weighing in), they talk about these nations as "developing," in terms of poverty, in terms of evaluative statistics* (observation, October 22, 2018).

There were students from the "developing world" sitting in the room and I noticed that these students were quieter in the context of this conversation. It may have been because those students came from an engineering background and were not as familiar with the content. Some of the European students and staff were engineers, and they seemed to have no hesitation to weigh in. It may have also had to do with different school cultures. In the West, students are encouraged to participate in discussion from early ages, whereas in other parts of the world, there is more of a hierarchical structure, where students are taught to listen to the teacher. I wondered at the time if the differences in their participation had more to do with the nature of the conversation, being dominated by Western thinking and the marginalizing way they spoke about "the developing world."

> *… there are people from around the world, including Africa and South Asia in this room. I wonder how the various students in the room feel about the nature of the conversation about Africa, poor/developing nations, poverty, etc* (observation, October 22, 2018).

Western development teaching and interventions appear to hinge on the process of stakeholder engagement, as if, by "engaging with stakeholders" or "engaging with community," Western outsiders can help to surface or determine "needs" and then deliver "solutions."

During another social science module, students learn about social research methods to support their field work. Figure 1 is from a lecture in the module, depicting a project cycle for "systematic rapid assessment."

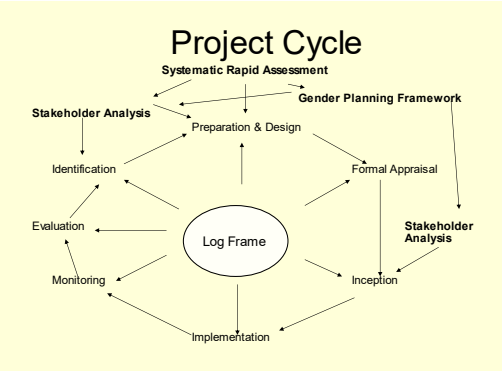

Fig 1. Slide from MSc module

Though the class where this project cycle was taught involved considerations of "participation," the framing of participatory methods still seemed to rely on an outside "researcher" who assesses the lives and "issues" faced by a community/stakeholder group. The researcher takes the lead in collecting and analysing information and formulating an intervention. The assumption

within this module was that participation can open “up the possibility of involvement in planning and management of development projects and programmes” (observation, December 2018).

These various influences helped create the conditions where references to the “developing world” and the “Third World” were commonplace and acceptable. The way that development was framed in modules popped up throughout the year and was parroted by students. During a group meeting between students and staff to discuss final dissertation projects, one student made generalisations about “really high numbers of people” in the “developing world” and their approaches to cooking. This related to his technical dissertation, which was focused on a community-based model of cook stove technology.

> Luke: …really high numbers of people in the developing world still cooking off open fires and simple stoves and obviously this contributes to a lot of premature deaths and respiratory-based illnesses, mainly. … we’ve known this a long time, and there’s been lots of interventions that have looked at sustainable cooking solutions. Like … clean cookstoves is massive, you have community cooker…There's a number of reasons why these aren’t as wide spread as it could be and I think, to give an example of one, it’s gender dynamics, because you know, it's the women who cook, but it's the men who hold the money quite often and then they don't want to invest in a better stove for their wife to cook or what have you… So … there's lots of stuff already happening. But it's quite slow in this field because of those gender dynamics, because that market doesn't exist and … I think the power thing’s really interesting because, like what Biolight, that company with the stove is doing …they're looking at where you can use the waste heat to generate electricity. Well this is really interesting…we'd like to see gender mainstreaming, and we’d like to progress towards this, but now you've given a reason why the man now wants to upgrade his wife’s stove, because now he can charge his phone on it. So, he has an incentive to go and buy a better, more efficient stove...

I was struck by the way that Luke, a British student, discussed the “developing world” and issues of gender relations within it. He spoke in generalities about how men and women divide labour and spending, across the developing world, failing to differentiate between national, tribal and/or ethnic identities in cooking preferences or habits, or gender relations. He seemed confident in the Western development approach that Western-developed cookstove technologies could help bring “progress.” His assuredness and righteousness gave the impression of his authority over the path of development of others: “we’ve known this a long time” and “of course, we’d like to see gender mainstreaming.” The “we” in his statements seems to refer to him and people like him – white, Western holders of superior knowledge of how development should occur.

4 CONCLUSIONS

This paper aimed to demonstrate how the episteme of modern engineering, formed through forces of Western imperialistic and racialised colonialism, continues to act upon our discourses within modern day engineering education.

In this paper, examples from an ethnographic study of an MSc in engineering management for sustainable international development were provided to demonstrate the ways in which students, staff, and their external stakeholders reproduced coloniality. The course reinforced modern conceptions of development, which, though challenged and critiqued, have not significantly changed since their inception.

This is not for lack of good ideas or intentions. It is, in large part, because we still exist within coloniality – a totalising force on our modern world. This includes the pervasive modern discourses of progress and development and the ways in which they form and are formed by the structure of our neo-colonial capitalist economy.

Engineering, as a vehicle of colonial supremacy, became intimately intertwined with these discourses and structures. And the way that engineers are trained has not escaped these factors.

Decolonising efforts are making strides toward addressing the inequities and injustices that emerged out of colonialism. The episteme of engineering makes the work of decolonisation even more critical and potentially even more challenging, given the historical, cultural, epistemic, and structural roots of engineering and how closely intertwined they are with imperialistic capitalistic interests. Yet as educators, the purveyors of knowledge and professional socialisation, is this not part of our collective responsibility?

If we are to engage in decolonising work, we must start with careful examination of ourselves and the ways in which we may reproduce systems of oppression. This will require challenging positivistic ways of knowing and doing in engineering practice and education. As discussed in the introduction, what is considered valuable knowledge in engineering education and EER is still shaped by positivism, the philosophic position that fuelled imperialistic colonialism.

Critically reflective practice, or praxis, can help to uncover new understandings of history and power relations in engineering education. Paolo Freire's conceptualisation of a liberative pedagogy provides us solid ground upon which to open ourselves to alternative ways of being and knowing. It can help us open ourselves up to alternative philosophical standpoints from which to re-shape our ethical frames, as well as problem definition and problem solving in engineering. Ecological models, indigenous ways of being and knowing, and other subsistence forms of living may provide inspiration. Many of these models and frameworks exist outside of engineering education research – the decolonising work ahead requires the importation of these approaches into our knowledge and practice.

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