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HETEROTOPIA

ALTERNATIVE PATHWAYS
TO SOCIAL JUSTICE

Heterotopia

Alternative pathways to social justice

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Crossing the Threshold

A Journey into New Ways of Thinking

This book is about transformations. Particularly the sort of transformations that many would like to see happen in our profession, school, community and country. Transformations that lead to shifts in ways of thinking and being, about who we are, what we do and why we do it. Many of us are disillusioned with contemporary society and how the economic drivers and dominant discourse lead all to selfish, point-gaining behaviours. As we write this text, increasing numbers of riots, revolutions and peaceful protests are appearing on the global scene.

'Occupy Wall Street' has led to a number of other peaceful demonstrations against financial centres in major cities, which show that many members of our societies are discontented with the greed that they see in contemporary neoliberalism and are prepared to risk arrest and disruption to their lives to say so. The competitive behaviours they protest about act against community and a sense of social justice and leave us empty, bereft of direction, running in different directions at the behest of someone, but we have almost forgotten who and definitely, why. We attempt, in this short manuscript, to explore possible transformations to alternative ways of being, using a multitude of disciplinary traditions and experiences from different walks of life. We hope that it will be useful in provoking the development of a consciousness about transformation, which transcends disciplinary and professional boundaries and in starting a conversation, which will allow us to converse with each other about the changes we would like to see and how to help these happen.

What we aim to do with this text is to help find ways of deconstructing current issues and contexts and in reconstructing alternatives, which move in more just ways. We do so, by drawing on many different disciplinary traditions as well as by using very different examples of 1) a profession, using the particular case of engineering, a practice done by highly trained workers entrusted with building services, products and systems for different parts of society, and; 2) a local community touched by, but with no power over, these professional worlds.

In our exploration of transformations to new alternatives, we began by drawing on one particular education theory, known as the 'threshold concepts framework,' which is concerned with the transition from one relatively stable state of knowing or being to another. Erik Meyer and Ray Land who originated the idea, use the terms 'liminality' or 'liminal space' to describe this transition. The term comes from the Latin 'limen' meaning passage or threshold. Liminality is a space of uncertainty and flux which different learners will navigate in different ways and with different success, some might for example get stuck, unable to move forward, while others will oscillate back and forth between different states of knowing and being. However, the kinds of transitions we are considering are not linear, not the learning of simple isolated concepts, they are messy, abstract transformations. The space, which describes the learning journey we speak of, as well as its destination, is more like a 'heterotopia.' Heterotopias are places and spaces, described by Michel Foucault in the text 'Of Other spaces' as 'non-hegemonic.' The place where Occupy Wall Street has been happening is an example

of a heterotopia: a place where alternatives are considered, 'common sense' is questioned and business as usual stops for a moment.

'Hegemony,' the term coined by Gramsci, will be explored in more detail in the text but for newcomers, suffice to say that it refers to the dominant ways of thinking, propagated, reinforced and made 'common sense' by those in power in society. In this book, we invite people into this very liminal, heterotopian space so that they might rest a while and make decisions about what to do next, without being bombarded by what others seem to think are 'common sense' ways of being and thinking but which we think are madness.

In their discussion of liminality, Meyer and Land differentiate between different liminal states which is something we will expand upon in the text. One aspect of Meyer and Land's discussion is 'subliminal variation,' which they conceptualise as variation in predisposition toward knowledge building in a disciplinary knowledge area or awareness of the 'underlying game' that structures or informs a discipline. This subliminal variation will influence how learners can and will negotiate different states of liminality and thus give rise to further variation. For the purposes of this book we can interpret this subliminality in a broader sense as a person's predisposition toward engaging with the road to heterotopia. This is a way to make sense of some of our examples of certain books we picked up or people we met who resonated with our selves greatly, despite the sometime randomness of the first encounter. After all most of us (most people) have picked up books or met new people by chance, but (potentially) it is our states of subliminality that influences how we engage them. Jack Mezirow, a founding figure regarding transformative learning theory, most likely would connect this to different habits of mind that influence our frames of reference and points of view. One key point of this book then is that when we become aware of (aspects of) our own subliminal predispositions we increase our possibilities to act and further transform our subliminality and selves. This is reflected in how we (in addition to chance meetings with texts and people) also consciously seek out certain new texts or people who might help us grow or continue to develop as individuals and part of communities.

In 1964 Marshall McLuhan told us that 'the media is the message.' In other words, he was claiming that the manner of doing things is itself integral to the content being expressed. In this book, the subject matter will be presented in a manner consistent with the ideas being described. This may sound simple, but it creates challenges for both authors and readers. This introduction will lay out the contours of the discussion and the range of material to be encountered. We will do so in part by each author speaking from their own positions and experiences (John, Caroline, Jens) where these are different from each other.

We are going to explore transformations, what is possible, what we think about it, what terms we might need, what thresholds we have to cross, when acting as a socially just citizen or 'professional' in our current societies. In the text we will be using 'engineering' as an example of a profession whose work affects everything that we do, how we act and behave on a day to day basis. The way we approach our critique of engineering may be applied to any such profession (law, medicine, commerce etc.) so we hope to make it as accessible as possible to any reader. This transformation is mediated by the dialogues between an engineering academic who initiated the 'Engineering, Social Justice, and Peace' network (ESJP) (Caroline) and an engineering education scholar (Jens) in order to question the dominant paradigms in their profession. These transformations and our way of thinking about them is then critiqued and informed by our third author, a public theologian with expertise in political

economics and sociology (John) and who deals on a daily basis with the aftermath of global and local 'professional' economic, educational, medical, farming and other intangible decisions and policies. John is at the receiving end of the practices of the politicians, professionals and policy makers. We see these as very different angles or lenses onto the same problem.

Throughout the text, we reflect from a theoretical perspective on the issues and questions raised, we apply these to engineering as an example of the profession under study and we additionally ground this by transferring the ideas to personal experiential and down to earth contexts (indicated by text in quotation marks and in different font). We hope, in this way, to assist readers, as they move into the liminal space, to learn through experience of variation. Lets look at this idea of variation in relation to a child learning about colour. Variation theory suggests that we understand 'red' by the existence of 'blue' and by varying around the critically important aspects we get to understand these. Showing the child a variety of red objects so they can see that red remains the same, whilst the object itself changes (red book, red shoe etc.), then showing them a red book, a blue book, a yellow book etc. will help them see the difference between 'red' and 'book.' Hence we will present very different lenses to view the same phenomena, in order to describe the variation to be experienced, thereby highlighting its critical features.

As a result, what follows draws upon ideas and theories from a wide range of sources, some of which may be less familiar than others, some of which are very academic, others very practical and down to earth. We are aware that this presents a unique challenge to those who are more comfortable within their own particular discipline, or indeed are not engaged in academic discourse and its peculiar conventions, as well as those who are! We intend to make it clear where material comes from so that readers can pursue this for themselves if they wish. Since it is central to our argument however, that development and transformation are more likely to occur when different ideas are brought into contact and new combinations of thoughts and insights emerge, we do not intend to produce a grand theory about how these different ideas should be harmonised or brought together. On the contrary, it is consistent with our argument that concepts and notions that may not obviously or neatly fit together be brought into contact in order that what we call our 'heterotopian liminal space' might be understood. Even as authors, we are also in this space, experiencing it differently from one another.

"My first appreciation of 'liminal space' was termed, 'hanging out in the fog' after picking up a book by Guy Claxton entitled *The Wayward Mind: An Intimate History of the Unconscious*. Although this particular phrase does not appear in the book itself, he uses it on websites and educational programmes to describe the learning process that he advocates. As it happens it resonated at the time with a local community project that I called 'The Big Idea' (not to be confused with 'The Big Society'), which included at one point taking a coach load of people up onto the edge of the Peak District (in the UK) overlooking the village we had come from in order to place the settlement in the context of the wider geography of the area. As it happened, that particular day the Peak District fog descended with a vengeance and the participants were completely unable to see the next blade of grass let alone the village below! Yet, as with so many of these projects, a good time was had by all, and the British spirit triumphed over climatic adversity. What we ended up doing was, quite literally, hanging out in the fog, so the image was a powerful one." (John)

Guy Claxton suggests that in order to learn, grow and develop, it is necessary to enter a 'zone of entanglement' or what we are calling a 'liminal space'(assuming one is not there already) and not worry about trying to find our way out quickly or prematurely. In the book, *The Wayward Mind* he

backs this with up with detailed references to the history of our understanding of the human mind, making it clear that similar ideas about human creativity have been circulating for generations despite the cultural and intellectual differences. Amongst other writers, he refers to John Keats and his notion of 'negative capability': 'that is, when man is capable of being in uncertainties, mysteries, doubts, without any irritable reaching after fact and reason.' So one can let go of the need to be in control of the processes of one's own mind, can welcome confusion and the spontaneous swirling of ideas, sink down towards the unconscious and experience the benefits of doing so. Claxton links this to the ideas of other Romantics such as Blake and Hazlitt, and also to elements of the Christian mystical tradition the 'apophatic way' or the '*via negativa*.' One enters 'the cloud of unknowing' and thereby moves closer to that which is beyond definition or description.

'Heterotopia' is thus our starting point and our goal for this book. We will be discussing ways in which we understand transformations into, through and beyond such spaces, which allow us the freedom to be 'counter hegemonic' or question the dominant common sense of this millennia. We will be exploring a heterotopia in which engineers might find themselves if they wished to be more responsive, socially just professionals. We will look at this heterotopia through different lenses and these will in turn be the topic of each chapter. A brief introduction to each of these lenses is described below.

The first lens will be a critical lens, to be encountered in chapter 2, following a tradition of critical theories (the many different traditions of critique emanating originally from the Frankfurt school of Critical Theory) that of how to critique and move beyond the accepted or conventional wisdom within a specific field. For all the authors, Paulo Freire has been extremely important. Freire makes a distinction between the 'banking concept' of education, where the teacher or expert attempts to 'deposit' ideas or truth in the mind of pupils, and the notion of 'dialogical education,' where all students are treated as adults and what they bring to the process is seen as crucial. This was formative for all authors. What Freire offers is a process which is not in the control of the existing power structures but which potentially releases the more subversive ideas and experiences of those who are 'on the receiving end' of that power, hence it has the possibility of being not only dialogical but also profoundly democratic. His worked examples from Latin America are of great interest, but they do raise the issue of how this might operate in very different cultural and political context, which was, and still is, very real for those of us who wanted to use ideas from Freire or Liberation Theology in an affluent setting.

In chapter 3, we refer to the work of Antonio Gramsci and his concept of hegemony, and therefore implicitly the means by which the power of ideas to impose interpretations, and therefore practices, on others, can be challenged. We find Gramsci's notion of the 'organic intellectual' of equal use. This is the idea that those who resist need to be directly involved in grass roots action and not simply detached intellectuals coming up with grand theories that bear little relationship to the realities on the front line. All three authors of this book aim to fit the bill of 'Counter hegemonic organic intellectuals'!

Following from our interest in Gramsci's work and also the scholar Ludwik Fleck, who introduced the ideas of 'thought collectives' and 'thought styles,' we question the 'common sense' that is to be encountered in the discipline of engineering. This is the 'common sense' which is socially constructed by the dominant ideas of the time. In everyday jargon we use the term to mean 'sensible,' following our knowledge and judgement. This sounds good but of course if our judgement is 'constructed' by

others or by our social context and upbringing, we need to question the motives and values of the society in which we find ourselves, before deciding if indeed following our 'common sense' is the most appropriate thought or action. Hence the idea of common sense in this way takes on a more sinister meaning. The implication of this for our story is that certain ideas or ways of looking at the world, in this case the link between engineering and capitalism, become the accepted or conventional wisdom within the profession, so much so that people are not even aware that there might be alternative perspectives. It is just taken for granted that the main purpose of engineering, in this case is to serve the interests of business and the profit motive. Other views do still exist, but they tend to get filtered out because 'common sense' prevails.

We are keen to show that similar ideas occur in other disciplines and that there is value in making these links and drawing upon wider resources in what the philosopher Wittgenstein might consider to be 'family resemblances.' So one is not arguing that these are all the same, but only that there are enough similarities to make the comparisons fruitful and interesting.

There are parallels here with the concept of plausibility structures as described in Peter Berger's book *A Rumour of Angels*. A plausibility structure is a framework of interpretation or understanding which has become the accepted wisdom within a field of study and makes it possible for some things to be believed and others to be dismissed as not believable. An example of this would be the idea of the miracle. If one holds to a strict view of the laws of nature which says that they cannot be broken, then clearly miracles simply cannot happen and any evidence that they do has to be either dismissed or redefined. Another example is the positivist mindset in science. If scientists are looking for one objective truth that fits within 'known' scientific models, they will reject new data which does not fit as 'outliers.' The effect of this is to create a dogmatic approach to the world, which rules certain possibilities out in advance.

A similar idea occurs within the philosophy of science and the debates initiated by Thomas Kuhn back in the 1960s when he introduced the notion of paradigms into science, in his book *The Structure of Scientific Revolutions*. He was also arguing that one can identify certain frameworks of interpretation or ways of understanding how the world is, that become the accepted wisdom, and that one can describe this as new paradigms becoming dominant in scientific study. This then led to heated debates about how precisely this happens. Can it be described as a rational process of some sort where there is suddenly enough evidence to shift the belief system and the 'old order' is no longer credible or acceptable, or is the process much more random and contingent upon extra-scientific factors? This latter view was presented by Feyerabend in a book called *Against Method*, which presented historical evidence to suggest that science 'progresses' in a much more haphazard and unpredictable way, and that narratives telling it otherwise are constructed after the event in order to justify the position being promoted.

What this makes clear is that the subject of power is central to the discussions in this book, even though it is not addressed directly by the authors. Breaking out of the thought styles, paradigms or plausibility structures and initiating innovative thought and practice is as much about how to resist existing power structures as it is about actual content, one could argue. As such, we refer to the work of Foucault and his notion of regimes of truth, as well as his considerable work on power itself. Particularly illuminating is his suggestion that power is not simply a zero-sum game, so that if one person or group has power then it is always at the expense of another person or group, but that power is more like the air we breathe. Power acts like a series of flows or forces in relation to which human

are located differently but always have the possibility of accessing. Thus nobody is ever 'powerless' even if they choose not to tap into the power that is available to them. There is always power and counter-power and thus the possibility of resistance. If this has some validity then it offers a more optimistic prospect for challenge and change, and that is something that all the authors of this book advocate and want to work towards.

Another philosopher whom we have found helpful in this context is Jacques Derrida. In particular, the idea of 'deconstruction' can be seen as another means by which existing and established interpretations can be opened up and challenged. This is the very approach that Caroline has introduced into engineering classes to enable students to think counter hegemonically. The word deconstruction itself needs to be treated with caution though and is often employed too easily and loosely by those who claim to be followers of Derrida but have not entered into his work rigorously enough. Derrida himself makes it clear that there is no one thing called deconstruction which one can then define and employ as some sort of emancipatory technique. One does not 'deconstruct' some concept or use of language and thereby automatically create its liberating opposite. It is more like showing in individual instances that alternative interpretations always exist beneath the surface of the conventional wisdom and are part of the original term in question. But there is never a simple reversal of meaning that overturns the existing one.

As with Foucault, this does suggest that the way to challenge power does not consist of overturning or reversing it, because one then simply replaces one set of power relationships with another. There are significant political and educational implications of this view. Rather than a straightforward overthrow of what exists, change is more likely to occur through a process of opening up which does not determine in advance what an outcome should or might be. We enter into a heterotopia. Hence one returns to the question of human agency and control. One does not destroy A by replacing it with B. One opens up the alternative possibilities already existing in A through a process of radical thought and engagement with other ideas, but without knowing where this will lead. Change is not a linear process, but essentially nonlinear and unpredictable.

The other parallel in this chapter comes from the discipline of hermeneutics, or interpretation theory as to be encountered in recent European philosophy and the work of Heidegger, Gadamer and Habermas.

Put simply there are two major conclusions that can be reached from this. First, interpretation operates in something like a circle; one has to start somewhere with some accepted views in order to even begin the process of interpretation. There are assumptions from which one then works outwards and that have not themselves been justified by the process itself. It is possible that these might in due course be called into question, but then the process has to begin all over again starting from different assumptions. Second, interpretation happens within a 'community of interpreters,' certainly in all academic disciplines. In this way individual or idiosyncratic interpretations can and will be checked against what the majority of one's colleagues accept as being true at that particular time.

This again raises the question of how much freedom or flexibility exists within a particular field or discipline when it comes to 'thinking new thoughts' or being creative or transformative. How does change actually come about and what costs are involved for those who would initiate it? To 'swim against the tide' in any thought field is a risky and costly business and one appreciates that some innovative thinkers have not been recognised or their views accepted in their own lifetimes. It also

poses the deeper philosophical question of ‘what is truth or is there indeed one truth’?

The initial common ground between the three authors came out of discussions about the educational process in their respective fields and the prospects for change and transformation, summed up in their use of the terms ‘threshold concept’ (troublesome and transformatory concept) and ‘liminal space.’ There is a shared assumption and common experience that change can and does happen, and that people can, under certain circumstances, begin to see and think differently. Much of the task then is to try to identify the conditions and circumstances, which enable this to happen, and these will be described in greater detail in the rest of the book.

In chapter 4 we consider the various models, theories, ideas, and metaphors that we and other writers use to think about change and transformation. We reflect upon models for the nonlinearity of learning as well as the model of a poppy seed head scattering seeds to the wind as a metaphor for personal and community development. We then move into the reflections of others. To help us in our quest for transformation through the ‘liminal space’ and into broader debates on radical change we access and contrast the work of Alain Badiou and Gilles Deleuze. For the sake of completeness, we also draw brief attention to the more recent work of the philosopher Slavoj Žižek, who has taken over the mantle of Derrida of late through a series of regular publications and media appearances. Although even more difficult to pin down in many ways, some of Žižek’s ideas have resonances with those just mentioned. His work tends to be less optimistic, if anything, and offers less hope of genuinely emancipatory action, but is perhaps a necessary counterpoint to the ideas, which emerged during the 1970s and 1980s. Using concepts from the French psychoanalyst Lacan, but also influenced by Hegel and Marx, Žižek suggests that replacing one set of dominant influences by another is not going to contribute to human progress. He even questions whether replacing one ‘Master Signifier,’ which is the term he uses to describe the dominant forces in the human psyche, by another, is possible, or whether it is better to leave that location in the human mind empty. Whilst not making matters clearer, Žižek does perhaps offer a necessary note of caution about what can actually be achieved by the struggles for freedom and change that fellow social activists and philosophers have advocated. Once again, there is a question of human autonomy and control and of how much can realistically be expected of political activity and radical thought.

This is where the process becomes more random and more challenging. All the authors would argue that the material mentioned so far has contributed to their own process of drawing on other people’s ideas to try to open up the processes of thought and activity, both for themselves and for those they have been working with. So we have presented different layers of words and ideas gleaned from a range of sources, that, at one time or another, have helped in thinking new thoughts.

It has been said, more often by perceptive four year olds commenting on how adults use language, that we should create new words so that new things can happen. This is the spirit in which we offer this book. Language is itself dynamic and changes organically, but is also subject to deliberate development as those on the edge struggle to express their experiences. Shakespeare has been credited with creating 3000 new English words, for instance, sometimes through neologisms, bringing together existing terms in new and unexpected combinations. It has also been suggested that, by doing this, he widened the range of emotions that humans (or at least English speakers) were then able to identify and express.

It is clearly true that language continues to develop and, by doing so, enables us to articulate and

experience ourselves and the world differently. One of our shared concerns is that the 'conventional wisdom' within certain disciplines acts as a strait-jacket and a cover for power structures, thus inhibiting and restricting the changes and challenges that ought to be possible. So we will set about creating and using new counter hegemonic terms which have been created, in order to enable the flexibility of thought and practice that could change our world for the better. We will attempt to enter heterotopia. To aid the reader with the language we use, we have created a glossary of terms which we might call 'threshold concepts,' which can be troublesome to understand but potentially transformatory; they will open up new and different ways of thinking. This will include some terms very familiar to some and not to others. However, as we wish to help the reader enter 'liminal space' and not to pass through we are not offering 'definitions' of these terms. They are simply highlighted, to say, 'we know these are new and strange terms, they have multiple meanings which you can start to explore, and by accepting that you will take a while to fully comprehend how you understand them, you will be entering your own heterotopia.' The glossary can be found at the end of the book.

One of the most valuable aspects of the work of Deleuze by himself, and it needs to be noted that this is different in important respects from the work he did with Felix Guattari, is his capacity to invent new words and new ideas that unsettle and confuse. At a later stage we will point out how terms such as 'state science' versus 'nomad science,' 'smooth spaces' versus 'striated spaces' and 'holey spaces' and many others, potentially suggest common ground and open up new ways of thinking about the world. It is like having to learn a new language in order to try to work out what he is getting at. But then, the same is true of struggling with Foucault and Derrida. Is it worth the effort, or is this just clever people messing about with words?

Heather Menzies would give a resounding 'yes' to the first question, and we refer now to her book *Whose brave new world?*, where she demonstrates clearly how language can confine and prescribe. Referring to George Orwell's *1984*, she worries that, just like using a term such as 'double double plus' to replace an adjective such as 'beautiful' and 'tantalising,' in order to control the emotions of the 'Proles,' we currently use language such as 'capitalising' and 'profiting' in place of 'benefiting' so that eventually we think they are one and the same. This is how our common sense gets generated.

Disciplinary domains are often the boundaries for the sort of common sense or thought styles, which define the language and tacit knowing of the tribe. The authors described above, especially Deleuze, offer a different perspective and explicitly break boundaries of all kinds, whilst writing about the boundaries themselves. It is clear then that in order to work in an emancipatory way, in order to break as many boundaries to knowing as possible, to break free from a thought style and to really consider multiple ways of being and knowing, ultimately we need to try to think through other ontologies or *ways of being*. We will not attempt to do this within this book, but acknowledge that we are privileging a Western knowledge system and worldview and know that we are necessarily limited in this.

In creating new words, we are creating new ways of thinking, opening up new patterns and consciousness. We would argue that new thoughts and language offer us one way in which one can move out beyond the 'enclosures' created by the thought styles and towards and through the 'thresholds' into other ideas and actions presented by more radical thinkers. Those of us who try to enter other disciplinary domains, know that the reception is often hostile, with a resounding 'you don't understand that thinker in the right way.' We need to carefully balance on the knife edge of creating our own boundaries whilst trying to break down others.

After hanging out in the fog for four chapters, we imagine that our reader will at this point be well and truly in a heterotopia. We invite you, in chapter 5, to consider a reconceptualisation, a new common sense, for engineering as a profession, which we hope may reflect somewhat on other disciplines also.

Throughout the text, we attempt to make explicit the principles on which we believe that engineering as a profession could operate, if it were to become a just profession, as well as reflecting on the difficulties of getting to that place. We all three reflect upon the work of others in disparate disciplines and how that feeds into our practical endeavours. There are a number of objectives at stake here: 1) to show that the concepts we are using have direct and practical implications and are not simply attractive ideas without any useful application 2) to link the search for social justice and concern to give a voice to those who are marginalised, from within engineering to wider spheres of activity in order to encourage others to engage in this type of heterotopian action 3) to reinforce the notion of the counter hegemonic organic intellectual by arguing that theory and practice come together through human responses to situations of injustice and exploitation 4) to suggest that at the heart of these debates and projects lie a number of assumptions that need to be made more explicit. These include our understanding of the way the world is; notions of how change can come about; the nature and role of power; and 5) our understanding of what it is to be or become a just and conscious human being.

It is the last of these which emerges as a constant theme through our writing and action. When we talk about liminal spaces, threshold concepts and 'hanging out in the fog,' what we are saying is that there are limits to the extent to which humans are in conscious and deliberate control of what happens. It is when humans attempt to determine, control and manipulate the lives of others that injustice and exploitation are most likely to emerge, and, by contrast, when they are most willing to experiment, spend time out in the fog and to let go of their predetermined ideas that creativity, growth and transformation are most likely to result. Both the ideas on which we draw and the practices in which we are engaged bring this lesson home again and again. This is why we wish to share our experience of heterotopia.

Critique of Established Positions

What is this profession called ‘engineering’?

We have decided in this book to use the profession of engineering, which we believe is in need of critical and urgent transformation, to test out our ideas. But if we are to use a profession such as engineering to view our concerns, we will need to start by exploring what engineering might be conceived to be in today’s society.

Engineering is both a *profession*, to be an engineer, and an *activity*, to engineer. A classical definition of engineering was devised by Thomas Tredgold on behalf of the Institution of Civil Engineers in 1828 that equates engineering with ‘the art of directing the great sources of power in nature for the use and convenience of man.’ A more recent definition of engineering is given by the American Engineering Accreditation Commission (ABET):

Engineering is the profession in which a knowledge of the mathematical and natural sciences, gained by study, experience, and practice, is applied with judgement to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind.

The last part of the ABET definition rings very similar to Tredgold’s 180 years older version. The purpose of engineers is still to control the forces of nature for the convenience of humans, but now with the added emphasis for this to be done economically. Another aspect has also entered the definition, the idea of engineers applying knowledge of mathematics and science to achieve their goals. In Canada the corresponding agency to the ABET is the Canadian Engineering Accreditation Board, which offers the following view of engineering and engineering education:

The engineering profession expects of its members’ competence in engineering, as well as an understanding of the effect of engineering on society. Thus, accredited engineering programs must contain not only adequate mathematics, science and engineering, but they must also develop communication skills and an understanding of the environmental, cultural, economic and social impacts of engineering on society and of the concept of sustainable development.

The emphasis here is on the notion that engineers must understand the impacts of their practice on society and the environment, which stands in strong contrast to Tredgold’s definition, which can be interpreted in a way that nature exists for humans to exploit. The European Enlightenment era left an imprint on all disciplinary fields, and the field of engineering was notably influenced. Many engineers see their work in positivist terms, even if they do not actually work in this way. Like many scientists, they take it for granted that their work is objective, and they see a huge division between the logic of their machines and the subjectivity of human beings. Some scholars have argued that as a result engineers have been employed as hired guns, at the behest of political rulers and wealthy corporations. Johnston and associates in their book *Engineering and Society* deem that the definition of engineering, should be ‘A total societal enterprise, with significant influences on all aspects of human

life and a major role to play in moving the world towards particular goals.’ The problem comes when the ‘particular goals’ of the political rulers and wealthy corporations do not match the needs of the majority of the people who should be served by engineering.

If we would like engineering to serve people and the needs of all people, we must then ask the question: ‘what would engineering look like if it were to focus first and foremost on people and not profit?’ We can ‘critique’ engineering through a ‘critical lens’ of ‘social justice.’

Mapping out the critical lens

We are using the term ‘critique’ in reference to the application of critical theory. The critical theorists of the Frankfurt School, such as Theodor W. Adorno, Max Horkheimer and Herbert Marcuse, are the originators of ‘Critical Theory’ and influenced the resulting critical social theories, which use a multitude of radical and less radical lenses through which to analyse social situations.

Rather perversely, however, when the term ‘critical thinking’ or ‘ability to think critically’ is used in the context of engineering, it is often assumed to refer to thinking clearly and rationally, and usually within the dominant discourse. This can actually result in the opposite of what we intend here, as what is seen as ‘rational,’ is often bounded within what is common sense within a given thought style. Emerging from critical theory, then, the term critical thinking takes on a different and more urgent meaning: the ability to see beyond what we consider to be ‘common sense.’ So developing a critical consciousness and critical thinking to enable ‘praxis’ (moving beyond critique to action) suggests the use of a ‘critical lens’ for looking at the world. In our own work we use the idea of social justice as a critical lens for engineers to look at their practice and profession and to begin to enter the heterotopia of alternatives.

In an extensive review in her book *Engineering and Social Justice*, Donna Riley explores a range of perspectives and movements that fall under the umbrella of social justice, ranging from faith traditions and human rights to ecology and critical theories, such as feminism and critical race theory. She acknowledges that it is difficult to define the term social justice. She tells us that ‘it is not that the term is poorly understood... each of us knows what we mean by it. The problem is that the term resists a concise and permanent definition. Its mutability and multiplicity are... key characteristics of social justice.’

Sharon Gewirtz in ‘Mapping the Territory’ argues that (social) justice has two dimensions, one distributional and one relational. According to her, discussions of social justice often become synonymous with discussions of how material and monetary resources are distributed in society. A more holistic approach to social justice also reflects the nature of the relationships which structure society. As an example of a holistic synthesis of the two dimensions Gewirtz puts forward Iris Marion Young’s idea of the ‘five faces of oppression’: *exploitation* (benefiting at the expense of others), *marginalisation* (being pushed away from participation in social life), *powerlessness* (being unable to make one’s voice heard due to lack of status or respect), *cultural imperialism* (the dominant culture becomes the way of interpreting social life) and *violence* (the risk and reality of being targeted with acts of violence). Both Gewirtz and Young agree that these are all mechanisms of oppression and social injustice and that these need to be addressed and countered when working to promote social justice. We adopt these considerations of social justice to frame our ‘critical lens.’

Critical theories of transformation within engineering education

The main work of Caroline and Jens is to critique the engineering profession through a critical lens of social justice and thereby develop a critical pedagogy for engineering education. If there is to be a critical repositioning of a profession such as engineering, this needs to start with a new generation of engineering students. We need to ask ourselves, as educators, how can we break free from the hegemony engineering currently experiences? How, instead, could engineering be focused around social justice? And how do we help our students see through a lens of social justice to critique their chosen profession?

Progressive educator bell hooks tells us in her book *Teaching to Transgress* that 'critical thinking (is) the primary element allowing for the possibility of change (within ourselves and society)... without the capacity to think critically about ourselves and our lives, none of us would be able to move forward, to change, to grow.' As an example hooks reflects on progressive education in *Teaching Community*:

Progressive professors did not need to indoctrinate students and teach them that they should oppose domination. Students came to these positions via their own capacity to think critically and assess the world they live in. Progressive educators discussing issues of imperialism, race, gender, class, and sexuality heightened everyone's awareness of the importance of these concepts (even those individuals who did not share our perspective). That awareness has created the conditions for concrete change, even if those conditions are not yet known to everyone.

hooks argues in the same book that her experience as an educator has shown her 'how easy it is for individuals to change their thoughts and actions when they become aware and when they desire to use that awareness to alter behaviour.' Her key point is that 'where there is consciousness there is choice

Freire has been a key influence for most critical pedagogues who aim to transform society to be more socially just, through 'critical' pedagogy. Freire's work stems from the perceived need to develop a theoretical framework to support educational practice for a less oppressive society. In his seminal work *Pedagogy of the Oppressed* Freire put forward the core of his framework: what he calls conscientizacao, which refers to learning to perceive social, political and economic contradictions, and to take action against the oppressive elements of reality. In English the term becomes conscientisation, or the process of developing a critical consciousness.

Freire differentiates between what he calls banking and problem posing or dialogical education. In banking education the relationship between teacher and students is hierarchical and knowledge is a gift from those who consider themselves knowledgeable to those they consider to know nothing. Banking education is not a way to help students develop a critical consciousness, but rather serves to preserve the status quo. Problem posing education, on the other hand, aims to break the hierarchical relationship between students and teacher and is a vehicle for developing a critical consciousness. The growth process takes the form of respectful and non-oppressive dialogue, which aims to help people develop their power to perceive critically the way they exist in the world with which and in which they find themselves. Key to Freire's work was the role of the oppressed in society. Central to his reasoning is that any true change toward a less oppressive society has to start with the oppressed. Freire was (initially) working with a class perspective, which is clearly still very important today, however his work has been used to consider various forms of oppression and the approaches that

education can take to empower.

“My first encounter with Freire’s work was accidental in that I was browsing a bookshop in Manchester and came across his *Pedagogy of the Oppressed*. It looked interesting and radical so I bought it. (Jens notes that this is the subliminal predis- position at work as discussed previously). Parts of it immedi- ately began to make sense while other bits were less accessible. My concern at the time was the distance between institutions and those who operate within them, and the people for whom those institutions claimed to operate and for whose benefit they were supposed to function. It seemed to me that, at grass roots level, people were turned into passive recipients of the services that the professionals either chose or were conditioned into offering and that no recognition was given to the actual needs on the ground.

What Freire seemed to be offering was an understanding of both power and communication that provided an alter- native model whereby ordinary people could gain the confi- dence to articulate their own needs and indeed feelings about what was happening. So it was not simply a matter of thinking through the implications of the different models of adult education, the banking versus the dialogical concept, but also of enabling people who were traditionally on the receiving end of various welfare services to gain a voice in the process. I will give an example of this.

I visited an old lady whose son had died recently. This happened just before Christmas and the weather was very cold and frosty. It was the son who had dealt with all the practical heating needs in his mother’s council (local regional government authority) bungalow on one of their large estates, and who had also contacted the council when necessary. When I saw her, she had an electric fire in one room and the rest of the property was cold because the heating system had broken down. It was obvious that she was at risk of hypothermia and she had no idea how to contact the council to get anything done. At that stage I also had no experience of dealing with council staff or who to contact, so I went home, did some homework and made some phone calls. Having got the usual ‘holding’ answer and promise that the problem would be addressed, I then left the matter for a few days. When I visited again, however, a few days later, nothing had happened and nobody had been to call. At this point I made contact with somebody with greater experience who said that the only way to deal with this was to threaten to phone the local press and to make sure that the story was on the front pages. One phone call to the council along those lines did indeed elicit the appropriate action and the problem was dealt with.

I began to wonder what sort of system this was that required that sort of threat before action was taken. How should the care of those in need be properly catered for and in what ways did the bureaucratic mechanisms and mindsets in place actually inhibit that process? What apparently had to happen was somebody coming into that situation as a catalyst or troublemaker and speaking on behalf of the particular person in need. But then what about all those other individuals who did not have anybody to speak on their behalf? There needed to be some way in which the estab- lished systems could be disrupted and disturbed and which would allow people themselves to articulate their problems and requirements. It looked to me as though Freire’s ideas, based on his own practice with marginalised groups in South America, had something important to say about this. Although I would not have used the language then, it was moving towards creating those liminal spaces or points of uncertainty and transition where new and creative activity could take place. At this stage I did not know that Freire had been an influence upon the development of Liberation Theology, but, in due course, I began to see how this was the case.” (John)

Transformations and thresholds

While awareness might be a necessary condition for change, we need to remember that, for Freire, conscientizacao had two dimensions: ‘to come to see’ and ‘to take action.’ Wilfred Carr and Stephen Kemmis in their book *Becoming Critical* point out that a process of critique can transform consciousness (ways of viewing the world) without necessarily changing practice in the world. In order to help us with the transformation process, we draw on two other educational theories: transformative learning and threshold concepts. Asking engineering students to look through a critical lens has the potential to be a troublesome and/or transformative experience since their ideas of themselves and their future profession are likely to be challenged, in other words it will not be easy for most of them. Jack Mezirow, who coined the phrase ‘transformative learning,’ describes in his chapter ‘Learning to think like an adult’ in the book *Learning as Transformation*, three related meaning structures: frames of reference, habits of mind and points of view. He defines these in the following ways: 1) ‘A frame of reference is a ‘meaning perspective,’ the structure of assumptions and expectations through which we filter sense impressions... (It) is composed of two dimensions, a habit of mind and resulting points of view.’ 2)

‘A habit of mind is a set of assumptions—broad, generalized, orienting predispositions that act as a filter for interpreting the meaning of experience... (It) becomes expressed as a point of view.’ 3) ‘A point of view comprise clusters of meaning schemas— sets of immediate specific expectations, beliefs, feelings, attitudes, and judgements—that tacitly direct and shape a specific interpretation and determine how we judge, typify objects, and attribute causality.’

Who we are is closely associated with the frames of reference we hold and changing or transforming these are often nontrivial. For Mezirow, critical reflection is the key to any significant shifts of frames of reference. However, he points out that subjective reframing commonly involves an intensive and difficult emotional struggle as old perspectives become challenged and transformed. Therefore it is important for educators to recognise the importance of a supportive environment to facilitate critical reflection and acting on any insights gained.

The troublesome nature of the transformation is explicitly dealt with in the threshold concepts framework. This is a growing body of educational knowledge which focuses on learning as passing through thresholds and enabling students to consider new and different ways of seeing the world. The assumption made within the threshold concepts framework initiated by educational researchers Erik Meyer and Ray Land, is that there are in most or all (disciplinary) knowledge domains certain concepts that serve as gateways to further progress as a learner and a deeper level of knowledge. The idea is that part of the process of grasping a threshold concept is that learners change the way they see the subject or part thereof and potentially themselves (in relation to the subject). The changes in thinking and seeing are what open up previously inaccessible knowledge areas. Meyer and Land suggest that the process to grasp a threshold concept also brings learners to adopt the ways of thinking and practising of the disciplinary community of practice in question.

The term ‘concept’ does not necessarily have to be interpreted in the narrow sense. For example, social justice is not a concept in the same sense as gravity or complex numbers are concepts in engineering; rather it represents a way of seeing the world. Not in itself a critical pedagogy, the most useful aspect of the threshold concepts framework for our purposes has been the term liminality, which is a space of uncertainty, flux and transition between two more stable states of knowing, being

or seeing. By acknowledging that learners will navigate a particular liminal space in different ways and with different success, some might, for example, get stuck unable to move forward, Meyer, Land and Peter Davies introduced the notion of variation and different states of liminality. They discuss preliminal, liminal, postliminal and subliminal variation, that is variation in the ways in which students see the concept come into focus, pass through the threshold, come out the other side, and their predisposition for knowledge building in the discipline. In our work we have re-framed this somewhat by introducing the notion of a continuous liminal spectrum, which goes from preliminal to postliminal. An illustration of this can be seen in Figure 1.

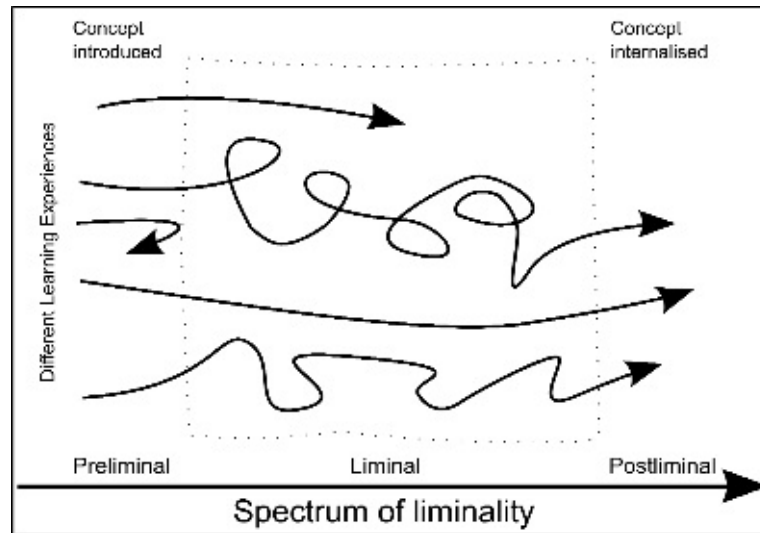


Figure 1: A visual representation of the variation present among students navigating a liminal space connected to a threshold. Some might pass through without much effort, while others take more winding paths that might also involve much backtracking. Yet others might get stuck or choose not to engage with the concept any further upon first encountering it.

An important aspect of our work to note is that whilst in conventional interpretations of threshold concepts, the focus is often on acquiring established ways of thinking and practicing, our aim is to introduce new ways of thinking and seeing into engineering. Based on our research we suggest that current dominant engineering ‘common sense’ can serve as a barrier toward social justice and thus social justice can be seen as a threshold which when traversed could potentially change the profession. Our goal as educators is to understand the barriers to the development of a socially just lens and pathways around these into heterotopia.

A worked example from engineering education

One particular course which Caroline introduced into two different Universities, Queen’s University in Canada and the University of Western Australia, ‘Engineering and Social Justice,’ was specifically intended to help students pass through the threshold and see engineering through a lens of social justice. Engineering and social science students took the course together. In line with Freire’s conscientizacao the aim of the course was not only to raise awareness among the students of social justice, but also to help them engage with the issues raised and shift their ways of looking at themselves, their profession, and the world. Students were interviewed about their thinking related to engineering, early and late in the term. In addition, student self-reflections on the course were collected. Among the engineering students in the class, seven different but related, articulations of changing perspectives on engineering could be discerned. These were:

A: Critique of the hegemony of engineering education

B: Critique of the hegemony of the current profit paradigm of engineering

C: Critique of the notion of a 'right answer'

D: Critique of the 'common sense' of technical solutions

E: The need for engineers to be humble and open to critique

F: The need to ask who do we, as engineers, engineer for?

G: The world is confusing and how do we as engineers fit in?

The theme running through all of these were the deconstruction of the students' original perceptions of engineering. Below we give some examples of student quotes for each theme.

A: Critique of the hegemony of engineering education

In the engineering curriculum we are programmed to determine an answer and we are not always asked to question the situation at hand. In general the questions of why this task is being performed and who it is affecting are simply not asked. I feel as if this class has helped me to be more critical of different situations I face, and I found that this class was very informative and eye-opening.

Here the critical aspect is the focus on how current engineering education promotes a certain limited way of thinking, which, for example, favours problem solving over problem posing.

B: Critique of the hegemony of the current profit paradigm of engineering

It's the social, environmental and economic... some companies have tried to go for it, but I think that it might be one of the most important things for an engineer to consider the true bottom line and (that) it's not just about the money. And to think about what are the social implications and the environmental implications and how there are gains and losses from all of them.

Here the critical aspect is the focus on how current engineering practice usually is strongly aligned with a purely economical perspective on the expense of social and environmental considerations.

C: Critique of the notion of a 'right answer'

(The course) taught me that my opinions and my ideas don't necessarily have to be right or wrong as they very often are measured and considered in engineering, right answer, wrong answer, and it's just very weird to think 'oh! here's an idea and that's all it is,' it's just an idea, it's not an answer or right or wrong... you could judge it accordingly.

Here the critical aspect is the focus on how there exists in engineering education a notion that there always is a 'right' in any given situation rather than that there can be several 'right' answers depending on one's perspective and context.

D: Critique of the 'common sense' of technical solutions

Knowing the underlying social cause of the problem changes the way in which the problem can be

dealt with. Critical examination of social causes rather than a focus on only technical problems is something I never considered before, although now that I think about it, it appears to be in fact much more important than the technological factors alone... (The project) has changed my perspective on social issues and has led me to believe that the engineering approach to problem solving taught at (University) is generally not the most comprehensive and is severely lacking in social consideration when working in the 'real world' outside of school.

Here the critical aspect is the focus on how engineering practice centred on solely technical solutions will be severely lacking for adequately addressing most situations involving people and how a more holistic approach is needed.

E: The need for engineers to be humble and open to critique

(The communication skills gained from the project) have allowed me to slowly begin to dismantle my own 'ivory tower of engineering' and to begin to fully engage with the issues I am examining on a much more holistic level... By stripping myself of the prestige of engineering I make myself vulnerable to critique as well. I consider this vulnerability to be central to a socially just design process. As flawless as the technical minutiae of a project might be, no design will ever be perfect in four dimensions. The design process must then incorporate a reflexivity that allows for it to change with time and conditions, be they social, physical or otherwise.

Here the critical aspect is the focus on how engineers need to realise that while they might identify as problem solvers they do not know everything and need to be humble and open for critique to be able to find appropriate 'solutions.'

F: The need to ask who do we, as engineers, engineer for?

When brainstorming ideas for a product design for our project I couldn't simply suggest for example a chair as I would normally do in a brainstorming session. I had to stop, think, and deconstruct my suggestion before suggesting it to the group. I had to think who the chair was for, was it useful for (people in country A)? Was there a market?, would (specific group of people out on the margin of society in country A) benefit from a chair? This differed completely from an engineering brainstorming session where I would suggest anything as long as it could be physically manufactured in an engineering context.

Here the critical aspect is the focus on how engineers really need to consider who they are creating solutions for, that is to say, 'Who is the audience?'

G: The world is confusing and how do we as engineers fit in?

I think the lasting impression is going to be that I need to do a lot of thinking about what I'm going to do after I graduate. And I think as of most of these issues that aren't engineering issues,

where you walk out and say okay one plus one equals two. You walk out of it feeling like you knew less than you did when you walked in and you have to do more research and you have to think about the issues more. So I do feel I'm going to walk out of it feeling, personally, that I need to think hard about what I'm going to do after I graduate, but I also think I'm going, just in general, to feel like the world is more confusing than I thought it was.

Here the critical aspect is the question of how one as an engineer fits into a world which seems more complex and confusing than before and the growing realisation that most issues in the world are not engineering issues.

In summary, we can see some clear patterns emerging. As defined by the students' perceptions of what we were helping them to learn, engineering as seen through a lens of social justice requires engineers to:

- 1) be able to critique their own practice, so as to question assumptions behind the common sense of the dominant discourse,
- 2) to question who they are engineering for,
- 3) to move away from positivistic notions of one right answer to allow for pluralistic diverse ways of knowing and being,
- 4) to be humble, open to critique and question their role in society.

We did not define this beforehand. This was a real example of a liminal space in the flesh. We assist students in their journeys, inviting them into the liminal space and this is how they described their heterotopia once they were there. The course is an interesting example of critical pedagogy. The students are clearly not the oppressed in society; far from it. However they are certainly able to critique their role in society, their role as students and the sorts of knowledge they are expected to learn in other classes. This is an example of the problem posing model whereby the learning is about developing a critical consciousness, not learning a prescribed curriculum. They were able to question (after Mezirow) 'habits of mind' using different 'frames of reference,' develop new 'points of view' and subjectively reframe their worldview. They were on a journey of transformation through the liminal space.

Thought Collectives and Common Sense

Common sense within engineering

It can be argued, as within any community of practice, that engineering students as well as practitioners and educators live within some form of ‘common sense’ that they have developed from their teachers and books and from the external social constructs of their society. ‘Maximise efficiency, reduce costs,’ for example, is considered common sense by most engineers working in industry, and it becomes difficult to question assumptions surrounding this view. Students and engineers today largely work within and unquestioningly contribute to the policies and agendas of the socially accepted neoliberalist, pro- development standpoint. This equates technical development with human progress and assumes that all people in all countries around the world will benefit from implementing Western style industrialisation. If we are to enable students to develop a critical questioning ability, and to position themselves from a stance of social justice, questioning the efficacy of these developments, we need to understand how these common sense views of engineering are developed and attempt to deconstruct them. Only then are we in a position to help students question the real cost and benefits and for whom, of current developments and to consider alternatives.

We draw from Ludwik Fleck’s work on thought collectives to help us frame our ideas. Fleck defines thought collective as:

A community of persons mutually exchanging ideas or maintaining intellectual interaction, we will find by implication that it also provides the special ‘carrier’ for the historical development of any field of thought, as well as for the given stock of knowledge and level of culture. This we have designated ‘thought style.’

People can belong to many different thought collectives, but according to Fleck:

The individual within the collective is never, or hardly ever, conscious of the prevailing thought style which almost always exerts an absolute compulsive force upon his thinking and with which it is not possible to be at variance.

Fleck argues that stable thought collectives form around organised social groups (such as professional engineers), and that if a large group exists long enough, the ‘thought style’ becomes fixed and formal in structure. He also argues that the longer a thought has been conveyed within the same thought collective, the more certain it appears.

Related to this is the work of Michael Polanyi, who is best known for his ideas about tacit knowing. While Polanyi seems to have been more interested in the act of knowing rather than the nature of knowledge itself, others have used his ideas to focus on the latter by discussing tacit knowledge. One such example is Meyer and Land who identify tacit knowledge as one of the different forms of troublesome knowledge relevant for their threshold concepts framework, which was described in the

previous chapter. In their work, they develop the idea that students find thresholds in their learning and tacit knowledge becomes a barrier and one potential cause of these, to the uninitiated novice. They link tacit knowledge to Etienne Wenger's ideas about communities of practice; for example different disciplinary communities have their own shared, unspoken understandings and ways of doing things.

Both Fleck and Polanyi hint at dominant ways of seeing or understanding the world within a given community of practice or thought collective. This has obvious connections with the ideas of Gramscian 'hegemony,' or what seems common sense to a community.

Hegemony is considered a process of social control which is subtle in that it is not evident or even potentially conscious control, but it is carried out through the moral and intellectual leadership of a dominant sociocultural group. The most important element is that this hegemonic sense is regenerated by the community who accept it as common sense. Thus, the 'common sense' which a group of people share and understand is of course not at all 'common' to everyone.

We argue that engineering may be considered a particular community of practice, with an associated common sense and thought style. If engineers blindly accept, and do not question the 'common sense' that they work within, they will be part of a thought style that they were not even aware of. All too often engineers are not in a position to do this critical questioning, as they did not learn the skills in school or elsewhere.

To enter this alternative space there must be a willingness to encounter ideas from different sources, a safe space within which to experiment and try out different ideas, an awareness of different ways in which individuals learn and grow, plus the creation of new language and a different discourse.

A worked example from engineering

A classic encounter that can be described as entering a liminal space is when one is forced to examine taken-for-granted practices, 'common sense' and ideas and encouraged to think new and often challenging thoughts, whilst 'hanging out in the fog.' In the terminology of this book, the established thought style surrounding a particular issue is brought into question. The example described here fits this description and offers a number of other supportive insights into the nonlinear process of learning presented throughout the text. It is both an important issue in its own right and an excellent example of the case we aim to present.

We refer to a recent book on the subject of the future of the car (*After the Car* by Kingsley Dennis and John Urry, researchers from Lancaster University in the UK) which has brought this to our attention in ways that we had not previously considered and utilises resources that one might not have thought relevant. The book presents the now familiar environmental arguments related to the theme: the problems of climate change and global warming; the threat posed by peak oil; population growth and particularly the rapid growth of megacities. Assuming one accepts the figures presented, it is clear that we are facing significant environmental problems to which the expansion of car ownership and use are major contributors.

The argument, however, takes the debate much further, and enters the territory of the role the car plays in wider economic and social life. Hence it states that there are five areas where we need to acknowledge that the car is so much more than a means of individual transportation. These are: the c

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