



OPEN LECTURE

DECOLONISING ENGINEERING

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2nd November 2017

The intention of this lecture is to provoke discussion. So, as a greying white male, coming to talk at UCT where all sorts of things are falling, in a Cape Town that is suffering its worst water crisis for decades, I chose the theme of decolonising engineering. I did this to highlight challenges of professionalization and social transformation in South Africa. And to make the point, I will suggest that Cape Town is an example of what can go wrong if you don't decolonise, specifically that the current water crisis has been created by an administration whose approach was encouraged by local environmental activists who think they live in Europe. Perhaps, if nothing else, I may succeed in uniting, however briefly, some rather diverse strata of society in common displeasure and discomfort about some part of what I have to say.

The combination of topics is chosen because I hope that it will be helpful as we face what is, unusually in this society, a truly common challenge that affects all more or less equally. There is nothing quite as levelling as standing in a queue with a bucket to get water and then carrying it home.

Engineers and engineering, as well as the wider community of technical professionals, are at the centre of my concern. The SA Academy of Engineers promotes these lectures because we believe that engineers and engineering have a vital role to play in South Africa's future. **But the specific questions that I consider are about what engineers must do to turn this vision into a reality, what (and how) can professional engineers do to keep policy debates technically informed while contributing to the South Africa's ongoing transformation; and what can we learn from Cape Town's immediate water problems?**

The theme of decolonisation and engineering provides us with a context to consider our current challenges and reminds us that, like so much in our society, today's engineering practice has clear colonial roots.

To illustrate this, consider the experience of Arthur Lewis, an economist. Few people recognise the name and even fewer know his history. Arthur Lewis won the Nobel Prize for economics in 1979 for his work on growth and employment in Africa. That much is a matter of record. Less well known, although it is part of the same record, is that he originally wanted to become an engineer. He only got into economics by accident, after he had won a scholarship to study in Britain.

"In 1932 I sat the examination and won the scholarship. At this point I did not know what to do with my life. The British government imposed a colour bar in its colonies, so young blacks went in only for law or medicine where they could make a living without government support. I did not want to be a lawyer or a doctor. I wanted to be an engineer, but this seemed pointless since neither the government nor the white firms would employ a black engineer."

The rest, as they say, is history.

"Eventually I decided to study business administration, planning to return to St. Lucia for a job in the municipal service or in private trade. I would simultaneously study law to fall back on if nothing administrative turned up. So I went to the London School of Economics to do the Bachelor of Commerce degree which offered accounting, business management, commercial law and a little economics and statistics."

The life and work of Arthur Lewis, born in St Lucia in the West Indies, the first and only black person to win the economics Nobel, should be the subject of another lecture. What his story shows is that engineering in the European colonies (and their associated dominions) reflected the wider discrimination of European societies at that time. It encapsulates the reality of colonial racism as it impacted on our profession in the past century. How embarrassing that he could not become an engineer. What could he have achieved if he had joined us instead of the economists?

Well, would he have been welcomed? Given the nature of the work that the profession was doing, he may have been uncomfortable. The history of the Anglo-Saxon wing of the profession suggests, I am afraid that engineers were, in many cases, implementers of colonialism. One part of the 1870 mission of the Institution of Civil Engineers is well known:-

"A Society for the general advancement of Mechanical Science, and more particularly for promoting the acquisition of that species of knowledge which constitutes the profession of a Civil Engineer; being the art of directing the great sources of power in Nature for the use and convenience of man"

Pass, for the moment, the gender bias. It continues:-

"... as the means of production and of traffic in states, both for external and internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation, and docks, for internal intercourse and exchange; and in the construction of ports harbours, moles, breakwaters, and lighthouses, and in the art of navigation by artificial power, for the purposes of commerce; ..."

(water was squeezed in, as an after-thought:- *"...and in the drainage of cities and towns"*)

If civil engineering was mainly about means of production, trade and commerce, the profession cannot exempt itself from criticisms of colonialism. A distinction was traditionally drawn between civil (as opposed to military) engineers. But it was these engineers who built the roads up which the occupying forces advanced; laid the tracks of the railways that enabled the metropolises to extract our raw materials to create their wealth. Indeed, Lewis from the vantage point of economics insisted that resource colonialism, the beginning of the new international economic order, began as “... an off-shoot of the transport revolutions. The railway was a major element here.” So, yes, the colonial powers may also have provided water and sanitation, but that too was mainly for the colonisers, not the country as a whole, a legacy that we are still dealing with in South Africa; *apartheid* planning had separate standards for white suburbs and black townships.

Civil engineering was part of the process of colonisation here in Cape Town from the start. The first civil engineering contract was for the canal dug to lead water to the Table Bay foreshore, to supply passing ships of the Dutch East India Company. And the history of subsequent expansion is commemorated in works of which we are, justifiably, technically proud - the roads, mountain passes and railways, the dams, power stations and transmission lines. But it was these that enabled settlement and made mining possible. So I am afraid that the engineers, while perhaps not the architects of colonialism, were often its builders and facilitators. And, not least because black people were excluded from the profession in the past (and therefore there are still relatively few black people in its leadership today), the local profession carries some of the stigma of that past and is not always trusted to serve the interests of the majority.

This is unfortunate because, in themselves, the capabilities, activities and approach of the engineering profession have a great deal to offer. So I am not here to denigrate the profession. On the contrary, I am very proud to be part of it, not least because in a world where there is a great deal to be done, engineers are often at the centre of making things happen. We have seen that from China to Ethiopia, engineers have often led their countries through important transitions and transformations. This is in the nature of the profession; the very word ‘to engineer’ has two distinct meanings and I like to think that the best members of the profession manage to do both, “to

- design and build (a machine or structure)
- skilfully arrange for (something) to occur “

Certainly, in Africa, we need to design and build for a better future for our rapidly growing population. Making it happen, against many odds, is a permanent challenge and it is certainly not happening as fast or as effectively as we might wish. It cannot help progress if the engineering profession is regarded as alien to African interests, a colonial throw-back.

Need it be so? To answer that, consider what this philosophising means for Cape Town?

I asked what ‘we’ need to do to meet African challenges. But who is this ‘we’? A critical focus of the decolonisation debate is determining who is (and should be) the principal agents and the objects; who decides what subjects are to be addressed? And, it is in the cultural history of the profession, and its role in South Africa, that this remains confused, nowhere more so than in Cape Town.

It is a little indelicate, at this moment, with system storage so low at the end of what should have been the rainy season, to use the current water problems of Cape Town as a case study. But water is a wonderfully patient teacher. Every year, the hydrological cycle behaves differently in its detail but offers us certain generic patterns that help us, through observation and analysis, to understand it

better. In particular, extreme events such as the current dry period offer important teaching and learning opportunities. Suddenly, everyone is interested in water.

The technical issues are relatively easy. The engineering approach to Cape Town's water supply starts from the proposition that a conurbation with a steadily growing population of around four million, needs a reliable water supply that will grow with it. This is a challenge. The region has no single large freshwater source, a river or lake nearby that can simply be tapped. So the technicians review the smaller and less obvious options. They then seek to reconcile the options for water supply with the demands.

This has been going on since Cape Town was established. As demand exceeded the capacity of small streams from the mountain, larger sources were tapped, the Breede and Berg rivers. But there are many other options. In 2007, a list of almost 40 was whittled down to just over 20 that could be developed over a reasonable time period, of which six were still being recommended (in 2013) to meet needs up to 2035. Reuse and desalination were among the candidates. Reducing water use rather than increasing supply has been a formal option since the 1980s.

The logical approach is to choose the cheaper options first and leave more expensive ones for the future. But this process of reviewing and choosing from the options and reconciling with the demands will be repeated for as long as people are living here and their needs – and their preferences, which are not the same thing – change.

The technical analysis is not as simple as it appears. Determining how much water can reliably be tapped by a dam on a mountain stream requires analysis of rainfall and streamflow data and its variability; estimating how much water can be tapped from groundwater needs geological surveys and mapping, drilling and pumping tests to be interpreted. Often, assumptions must be made, based on similar situations elsewhere.

It is even more difficult to estimate water demands (and that is before taking policy decisions on the always contentious balance between demands and need). To start, it is necessary to know how much water is currently being used. This is more difficult than most people understand. Is water measured going into users premises? How much water is put into the pipes at the source? Where does the rest go? How much does demand vary? And why? There is often as much art as science on this side of the calculations.

This planning highlights another problem: Engineers work to different time scales to politicians – and most ordinary people. For roads, power and water projects, we typically plan up to a decade ahead - five years is short term. Current water resource planning looks to 2035 and 2040. Meanwhile, for politicians, short term means this week, long term is until the next election.

Technical analysis may provide timely, useful recommendations to guide decisions and actions but the easiest decision is often to delay. This was already happening a century ago. Cartoons of the period show the (white) city fathers (no mothers involved) agonising over whether to build the Wynberg, Wemmershoek, Berg River or Table Mountain scheme; and then just shelving the whole idea for now – perhaps a few days of rain had removed the urgency. This is the same political cycle that has just put Cape Town back in the same situation as it was 100 years ago.

This repeated pattern of indecision and procrastination shows that engineering, certainly insofar as the practice of community water supply is concerned, is just one part of a larger social and political process. So water patiently teaches us not just about the vagaries of climate but also about the challenges of getting societies to work together to further their common interests.

What then does the current crisis tell us about the people and the institutional processes?

One of the underlying problems for Cape Town's water is that decisions have been made by people who think that they are living in Europe. Or, to state it in a more nuanced manner, Cape Town's approach has been excessively influenced by Eurocentric notions that have been shown to be inappropriate to a South African situation. Specifically, the local paradigm of scarcity, conservation and ecosystem priority that largely rejects and even seeks to reverse infrastructural interventions comes from northern Europe. As a participant observer, I recognise in Cape Town the thinking behind Europe's Water Framework Directive with its implicit rejection of the hydrological systems paradigms and practice-based methodologies that have kept most of urban South Africa water secure since 1994.

Despite its obvious limitations, this thinking has continued to guide Cape Town's policy encouraged by environmental activists and allies from this university although not necessarily from the engineering schools (One crude indicator is a citation review covering the last five years of "UCT and 'water supply'" shows that the additional keywords ecosystem, conservation and climate all have significantly more citations than 'hydrology').

This is not unfair because it keeps happening. Forget 1917. Around 2000, there was opposition to the construction of the Berg River Dam, identified as the next step in Cape Town's water supply. One confident view was that the dam would not be needed if only government did more to promote water conservation and clear all those nasty aliens from catchment areas.

This view, and the strategy supporting it saw loud and assertive people who enjoyed a certain 'social reach', dominating the discourse; crudely, they kept talking until everyone either left the room or agreed with them. In the first years of democracy, this conclusion was strongly advocated and intimidated two quite assertive national Ministers into paralysis. The trouble was that it ignored the fundamental challenges of the Anthropocene age and of the Africa in which we live – its growing population, with growing needs and often legitimate expectations that require alterations of the 'natural' environment, all this was rejected.

Nothing could be done until nature itself provided a crisis to make the point that action was required. A mini-drought occurred that helped to illustrate the need for action and quieten the noise for long enough for a decision to be taken. And *kyk hoe lyk hy nou!* Where would Cape Town be now without the extra 10% or so that the Berg River Dam contributed to the city's supply?

Do we learn from these experiences? A useful Master's dissertation could trace the limited impact of common sense and lived experience on Cape Town's decision making on water from 1917 to today. In 2013, those who inform and take decisions stated that the city did not need new infrastructure to increase its supplies because of its excellent demand management programmes. According to the minutes of the meeting, "the CCT has done much better than other metros in terms of successful implementation of WC/WDM measures."

I have shown elsewhere (Civil Engineering June 2017) that the mistake made was to attribute the effects of three years of good rains to demand management efforts and to conclude that the apparent savings would continue. Three years later, when the mistake became apparent, the first response was to say "... in our context, it is not practical to ring-fence billions of rand for the possibility of a drought that might not come to pass." But that was coupled almost immediately with the realisation that "it is impractical to fast-track supply schemes of sufficient scale quickly enough to compensate for a drought."

So I think that it is fair to use these examples to describe Cape Town's approach as 'colonised'. For most of my career, I have worked in African countries at the interface with people from Europe and North America, technicians, aid officials and policy makers who have arrived with clear ideas from their experience about how Africans should manage water, offering money as an incentive that is hard to resist. Too often, external approaches have been internalised so that, even when the northern thinking moves on, it persists in thinking and practice and does damage in the south.

This is pervasive around the role of infrastructure in water management. It is easy to understand why environmentalists, in places with temperate climates, old infrastructure (water mills, navigation canals, 'trained' canalised rivers), stable populations and relatively rich economies, want to avoid building new infrastructure and even to remove a significant amount of what exists, to 'restore rivers'. We don't need more water infrastructure, they say, we just need to use what we have more effectively. So water conservation and demand management approaches are codified in the European Union's Water Framework Directive.

This has caused big problems for the Southern Europeans, whose climate is more like Cape Town's is (or is supposed to be): wet winters and blazing hot summers during which water supply depends either on large perennial rivers or some form of storage. But it is particularly inappropriate for Africa. Africa is growing, in population, economic activity and urbanisation all of which drive an increase in water use. This is happening, even in Cape Town

This is not to say that demand management, encouraging efficient water use, is not important. In African contexts, it is essential, for social and economic rather than environmental reasons. We cannot afford to waste money, let alone water and the energy expended in making it available, in systems that leak, supplying users who unthinkingly consume far more than required to meet their needs.

The mistake is to think that efficient water use will reduce infrastructure requirements where supply depends on an unpredictable nature. Instead, it may simply 'harden demand'. If we plan for a reliable supply most of the time (98%, 1 in 50 years is the formal target for Cape Town) we are also implicitly planning what to do when that level of supply cannot be met. Traditionally, when supplies threaten to fail, we reduce usage by imposing restrictions – no garden watering, no car washing, install more efficient fittings and appliances etc. But if those things have already been done, there will be no more fat to trim. The option then is either to cut into the meat of what was deemed to be appropriate use, or increase the reliability of supply – and this often involves building more infrastructure to increase reliability, which will not be much different to what was needed for greater use at 98% reliability.

It wouldn't matter so much if failures only affected those involved in the decisions. But their decisions affect whole communities. In particular, they impact very directly on the lives of poorer people in a gender skewed manner, threatening further restrictions in communities where water supply is often already limited; livelihoods suffer too as restrictions coincide with the region's peak tourist and agricultural season. So it is chastening to note that Arthur Lewis was already warning, in the early 1970s, that efforts by western environmentalists to slow down investment and growth in the world economy to protect the environment, would likely make poor people poorer unless this was accompanied by many other changes. And we can expect to hear much more about who is restricted over the coming months and should not be surprised if those most affected choose to characterise themselves as the colonised and the decision-makers as the colonialists.

The big picture that Cape Town illustrates so well is that securing water supply is not just a technical problem. It is all about collective decision-making by the community concerned and how and by whom that decision-making is informed. In this case, important technical voices had only limited influence. The water shortages are just as much due to human action (or inaction) as to natural phenomena such as rainfall variability.

The question then is what can be done to ensure that appropriate technical responses to societies' challenges are developed and delivered? And, what specifically do engineers need to do? Aside from the technical work to identify and implement solutions, they have a critical role in keeping the political and social debates technically informed. But is that role accepted?

Definitions here help to highlight some inherent contradictions. So, a professional is someone who is either (or perhaps both?),

1. engaged in one of the learned professions, characterized by or conforming to the technical or ethical standards of a profession, exhibiting a courteous, conscientious, and generally businesslike manner in the workplace
2. participating for gain or livelihood in an activity or field of endeavour often engaged in by amateurs; engaged in by persons receiving financial return

The first definition is obviously the one that many engineers would like to be seen to live by. But we live in a world in which material gains are prioritised and a culture has developed in which experts are not to be trusted. This is not without good reason. Whether it is doctors manipulating research results to promote medicines of dubious efficacy, accountants and auditors who present information designed to mislead where it is not actually false, technical experts are too often not true professionals; they are just hired hands who promote the commercial interests of their employers – or their own. The water industry itself has some excruciating examples of this.

But healthy scepticism is now being systematically nurtured and harnessed and Donald Trump is the symptom not the cause. So, when academics and activists assert that water conservation and demand management will be sufficient to meet new water demands, why should hydrologists and engineers be believed? Aren't they just another group promoting its own interests? Never mind that their recommendations are based on over a century of experience, derived from mountains of data, using methods of analysis that have been developed globally to exploit growing computer power and improved understanding of the underlying physical phenomena. Besides, haven't they often been wrong? So why should we rely on their predictions of how much water is actually reliably available to Cape Town and how much we need? With new factors like climate change, surely 'This time it's different?!'

We need to think about where our professionals come from and how their role can be enhanced. In traditional 'developmental states' (where the state leads economic development, to enable social provision not the other way round), technical specialists in the bureaucracy enjoy a status of 'embedded autonomy'. They are part of the administration, but are protected from politicians who might seek decisions that serve political or personal, rather than technical, objectives.

South Africa's apartheid developmental state, illustrated this. The core cadre of engineers and scientists were educated and trained by the state, their bursaries required some years of obligatory state service after which some stayed in the public sector while others moved out into the wider society. This created a community of professionals who could cooperate around common goals.

They enjoyed a degree of trust that gave them considerable scope to implement and innovate, an environment in which it was possible to undertake complex and challenging projects.

This 'production line' has been lost as the state's capacity to absorb and train new graduates has collapsed, with most practical work outsourced. Many private consultancies have, in turn, been absorbed into international companies and have little incentive to train young professionals. This change has also broken the mechanisms that integrated new professionals into society as 'trusted experts'.

That breakdown has been aggravated by the impression that the professional organisations are closed clubs that seek to maintain exclusive privileges, not least to certify who is competent to perform tasks that require specific skills. This role has always been contested globally but the conflict is particularly acute in South Africa where it has been seen to enable a white old guard to control the entry of the new cadre of young black engineers.

Professionals can only be effective if they are trusted and supported by their society, which decides what tasks to delegate to their 'technicians' to protect the public against collapsing buildings, exploding boilers and failed water supplies. Professions may be allowed to self-regulate entry, as long as they don't exploit the opportunity for mercenary gain. Or it may be decided that more detailed engagement and oversight would be in the public interest. Whatever the approach, the concern for engineers is that their advice should be accepted and trusted.

The challenge for technical professionals in 21st century South Africa is to recognise that trust of 'experts' derives in large measure from their embeddedness in their society as well as their technical ability.

Once again, this highlights that water problems are primarily people problems. More systematically and precisely, some colleagues recently concluded that the world's water problems are not technical but socio-political. There are many technical pathways to the achievement of water security for our communities but the solutions are often complex and must be implemented over a long time horizon that does not fit political timetables. So politicians, administrations and the communities they serve find it difficult to make and implement decisions when they are needed. They don't panic at the right time but wait until it is too late to avert a crisis.

Of course, it is not just engineers whose expert advice is sometimes ignored. Arthur Lewis advised Kwame Nkrumah, Ghana's 1st post-colonial prime minister, not to build the great Akosombo Dam. He warned that it was premature and would use too much of the country's limited investment resources. His advice was rejected and he left Ghana to establish the University the West Indies. Not long after, Ghana's shaky post-independence cohesion collapsed and Nkrumah was overthrown, not least because the distribution of available financial resources could not keep the political peace between competing interests. 50 years later, the Akosombo Dam was enabling the country to keep its lights on. So both Lewis and Nkrumah were right; the challenge was in the timing.

To conclude, it is clear that engineering has been coloured by colonial objectives and attitudes that determined who came into the profession and what they could do; and, equally important, who was excluded, with what consequences. Because this history is still reflected in the structures of many engineering institutions, including those in South Africa, they are often perceived as an old fashioned and conservative force.

This is not helpful since engineers work in a world in which the role of technical expertise is increasingly challenged. Technical professionals are vulnerable because our solutions to apparently

simple challenges – like ensuring reliable water supplies - are often long term, complex and not understood or effectively communicated. This makes our recommendations easier to reject or just ignore.

Cape Town's plight reflects this. Its decision-makers were not telling lies when they claimed that they had permanently reduced water consumption through demand management. The mistake they made was to claim an easy victory, one which supported their colonial focus on demand management and ignored rather more obvious drivers, such as weather and population growth and options such as increasing supply. But engineers failed too. They did not make their voices heard to promote an alternative, cautionary, view because they were not adequately 'embedded' in the society.

What does this tell us about the role of the engineer?

As agents of economic activity as well as social development, engineers inevitably reflect the aspirations and priorities of the communities from which they come. But social attitudes to engineers as experts are also ambivalent. Decision-makers and their constituencies often prefer simpler and popular approaches. This further weakens the engineers' voice.

South African society will not be well served if it simply rejects engineers and their institutions. While the profession needs continued introspection, and its problems - limited transformation and narrow, socially and politically out-of-touch perspectives – must be acknowledged and addressed, this is unlikely to change the longer-term outcomes.

In many senses, these problems are already history; we should be paying attention to the new forces that are shaping the future. The composition of the profession is changing rapidly and radically. The present generational divide is between a rapidly dwindling group of senior white stalwarts and the majority of young, black entrants, including increasing numbers of women. The good news is that, over the next decade, the well-recognised gap of experienced 'middle professionals' will be filled. Many of today's young engineers who have had to learn without much mentoring will turn out to have absorbed a great deal of wisdom as they navigated their assignments in difficult circumstances.

But this change will not automatically transform other dimensions of the profession. The ideal engineer will still be expected to exhibit those qualities of objectivity, ethical behaviour as well as technical competence inherent in the positive definition of the word 'professional'. But engineers, already members of an economically privileged minority, often come under pressure to behave unethically to retain or improve that status. And there is no automatic assurance that they can or will bring different attitudes to their work insofar as it impacts on the wider community.

The challenges are most obvious for engineers in the public sector, responsible for the very foundations of society, the basic structures and services that we take for granted. But they also create huge dilemmas for the engineers who are service providers to that public sector. And similar challenges face practitioners in other fields of engineering, mining, chemical, electrical and mechanical. They all work in areas that can transform conditions for the larger society but are subject to its particular political economies.

We need to strengthen the ethical foundations that determine the outcomes of our work. And this will not be achieved simply by changing the colour or gender of the practitioners. So yes, we need introspection about the past – but, even more, we need a determination to do better in future. Part of that will be to do more to ensure that the voices of professional engineers are heard, as critical contributors to public debate, informing the decisions of policy makers.

Cape Town's tribulations are proving helpful. They show that a failure to take use technical expertise is not the province of just one political party. Perhaps this will teach politicians to beware of the arrogance of ignorance and learn to work in ways that harvest rather than ignore sound advice

But there are other challenges. Next year, I may offer a talk with a different focus, some place like Johannesburg or Nelson Mandela Bay. I will explain how their water security is threatened not by nature's vagaries and variable climates but by human failures, by decisions taken for reasons other than the public interest. One illustration will be DWS's response to its budget crises, throwing more money at failing infrastructure projects while slashing the already tiny amounts spent on planning them; the less said about maintenance, the better.

The future challenge will be to help engineer institutions and systems that effectively and sustainably improve the lives of all South Africans. I am still working on a title, perhaps "from old colonials and *compradore* comrades to a new kind of engineer". That is a subject for another day. This process is ongoing and will continue, and be contested, as long as our societies develop and evolve. Those of us lucky enough to have taps in our homes will measure progress by turning them on to see whether we can take this one of life's basic needs for granted.

Meanwhile, water will continue to teach us that whether it flows reliably is determined largely by people, not hydrology. We need the right decisions to be made at the right time, informed by the best possible advice. This may often come from a cadre of engineers that is respected and nurtured by the communities in which it works. That is where we should aim to find ourselves.