

*THE
ECOLOGY
OF
CONSTRUCTION*

Sam Amod



Sam Amod was born in 1958. He was raised in the Casbah district of Durban. He entered the University of Durban Westville at 16 and emerged with a degree in civil engineering and a broad education. The first 10 years of his career focused on structural engineering. During this time he completed a post-graduate qualification in Structures from Wits University and worked on a variety of structural projects in Johannesburg and Cape Town. He subsequently concentrated on project management and completed a Masters in Civil Engineering, also at Wits, before establishing Development and Engineering Consultants (DEC) in 1995. He has studied airports and aviation at MIT and management at Harvard Business School. He is presently Chairman of DEC.

Sam holds the unique position of being a Council member of both ECSA and SACPCMP. He has a passion for construction industry development and is the author or co-author of a number of publications. He is married with two children and lives in Johannesburg.

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Introduction

Ladies and Gentlemen, it is a rare honour to be elected to the position of President of the Institution. SAICE serves more than its members. Through its influential role in construction, it serves and represents South Africa. The work that we do at the Institution takes us beyond the borders of our country and our continent. To be counted among the distinguished group that has led the Institution over the past century is indeed a privilege.

It is an interesting exercise to review the Presidential addresses of the past 103 years. Over the first 75 or so years, they were mostly technical and data-centric, staying close to the specialized engineering knowledge of the speaker. Gradually they deviated to matters of management, planning, measurement, leadership and, on occasion, social comment. In this address, it is the broad construction environment to which I wish to turn. I refer to it as the “Ecology of Construction”: the complete and fundamental interconnectedness of individuals, organizations, resources and processes in the construction sector.

Engineering professionals¹ are resourceful. South African engineers are responsible for creating the infrastructure asset of this nation that makes us the envy of this continent and beyond. As engineers, we are trained to be analytical, logical, to seek the solution in the face of challenging problems. So our language tends to be dry, precise, unambiguous and often humourless. Emotion, we are warned, is distracting and irrelevant. Indeed, this is typical of the patriarchal society we have created, for we are predominantly a profession of men. Our methods and our creations reflect this deformity. It is easier and safer to stay close to codes of practice, “the bottom line” (often expressed to three or more decimal places), and formulaic reports. We find this much easier than expressing emotion and passion.

As an industry, we must strive for continuous improvement. And yet we understand that our role in society cannot continue to be purely as purveyors of technology. As the boundaries between professions become increasingly blurred and the public better informed, engineering professionals are required to interact at a human, not technical, level and to persuade, not simply specify. It is no longer sufficient for the technical expert to explain by saying.... “because it is so...”.

ecology: study of the relationships between organisms and their environment

In particular, our arguments for bringing about improvement in delivery, quality, safety or prosperity have been largely ineffective. Could it be that people are not convinced by the data? Or perhaps that data alone cannot persuade? Have we lost our ability to connect with ordinary people? I suggest that the essential ingredients that define our environment and influence our future are reflected in the way we embrace continuous change: in an ecological, rather than a mechanistic manner.

¹In this address I refer to the group of engineering professionals comprising professional engineers, technologists and technicians by the collective term “engineers”

Speaking the same language

Now, the idea of telling stories is not generally equated with engineering best practice. Rather, it is more often seen as embellishment or exaggeration. Nevertheless, let me take us back to France in the late 18th century, an age before cars and trains and planes, and relate a tale about global transformation.

Every town and village, it seemed, had its own standards for length, weight and so on. The local measures for length might be mortised into the walls of the local town hall and the unit for weight might be a lump of steel held by the bakers' guild. Of course they did not remain constant, nor were they identical to the measures in the neighbouring towns. It was estimated that France alone had more than 250,000 units of measure for length and weight! This profusion of standards affected commerce and administration, science and engineering, and hindered proper communication within and between nations.

Of course this was a time of limited mobility for most people, so the general populace saw little advantage in uniform standards. But for science and engineering the limitations were severe. The *savants*, the French intellectuals in the Academy of Science, decided to change this by agreeing to a universal standard of measure - what we now call the *metre*.

The debate revolved around what to use as a measure that would receive widespread approval. One option was to simply adopt one of the measures in use and declare it "the metre". But would this receive popular acceptance - not just in France, but internationally?

Using the Earth as reference was logical as it belongs to all people, but which reference line to choose? The equator is unique, but most of it traverses ocean or (in those days) inhospitable lands. To calculate the length of the metre accurately, a piece of the chosen reference line had to be surveyed (using triangulation) and a baseline measured. The start and end points had to be at sea level. On the other hand, providence had blessed France with the meridian through Paris - it also passes through Dunkerque on the North Sea and Barcelona on the Mediterranean. It appeared perfect for the task.

In the end, it was decided that one ten-millionth of the meridian from the North Pole to the equator at sea level (the quarter meridian), would be eternal as a measure "for all people, for all time". This would be approximately the distance from the fingers of your outstretched hand to the tip of your nose - a reasonable measure. On 24 June 1792, King Louis XVI authorized the "Meridian Expedition"². Two of France's best astronomers, Delambre and Mechain, set out on an expedition to survey the meridian and so define the metre.

Over the next few months though, the French Republic was declared, Louis XVI was executed and the countryside was in chaos. Instead of a few months, the expedition took seven years, a period that included Wars between France and Prussia, Britain, Spain, Egypt and Italy, the rise of Napoleon Bonaparte, and what we now call the French Revolution. Like today, it was a time of political and social upheaval.

² Alder (2004) provides a fascinating account of the Meridian Expedition



Built into the walls of the local congregation building (this one is the town hall of Laon) might be rectangles to gauge the size of bricks, others to measure roof tiles; lengths of metal to measure cloth or timber, and so on. It was the obligation of local officials to maintain fairness. In return they of course were entitled to extract a small fee.

In launching the metric system in the USA, President Gerald Ford in his inimitable style said: "When it comes to the metric system, US industry is miles ahead of official policy". His successor, President Reagan, abolished the metric system.

*In a world of disconcerting change, when large and complex forces threaten familiar and comfortable guideposts, the natural impulse is to grab hold of the tree trunk that seems to have the deepest roots and hold on for dear life and never question the possibility that it's not going to be the source of your salvation.
--- Al Gore, 2004*

Despite the chaos, the length of the metre was calculated and eventually became the international standard. This first serious attempt at standardization revolutionized engineering. Can you imagine the channel tunnel being constructed with two sets of measures for France and the UK?

Today, the only notable recalcitrant from this system is the world's superpower, USA, and even there an insidious process of change is underway. One reason is the Mars Climate Orbiter which disappeared at a cost of \$125 million in 1999 because one part of the team used metric units and another used imperial units.

The story of the meridian expedition appears far removed from us geographically and in time, but many in this audience will remember the old imperial units. I am sure that there are many among us who can only tell their heights in feet and inches. Even so, I doubt that anybody here would want to revert to that confusing system of measure. We have made the change. There are many illustrations closer to home that demonstrate our ability to evolve despite society's best efforts at resistance. Our own political, social and economic renaissance provides such evidence. We have learned that evolution and change is about releasing an old, familiar situation and embracing a new, unfamiliar situation. Sometimes it's not the old or the new that's tough - it's the time in between.

Transformation in Construction

The South African construction sector is at the threshold of radical change. The environment that has held consistent for many years, if in steady decline, is faced by the challenges of globalization, racial and gender transformation and steeply increasing demand.

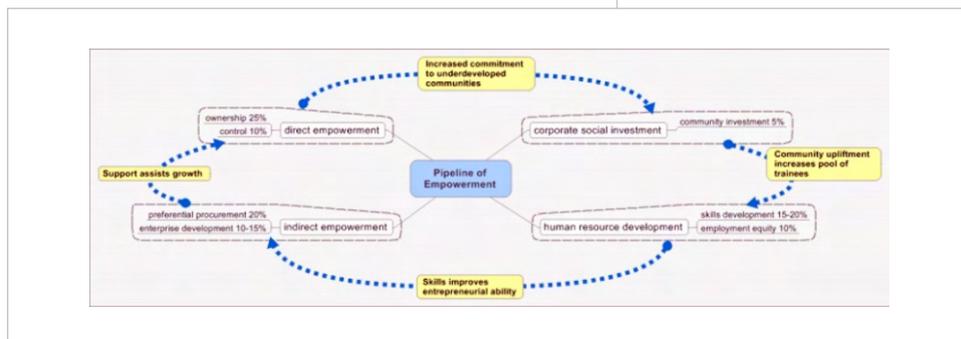
The recent introduction of registration for project managers and contractors, health and safety regulations, competitive bidding for consultants, standards for uniformity and various other procurement reforms, have presented challenges at a time when the industry is reeling under the increased demand for resources. If ever there was any doubt, SAICE's publication of the *Numbers and Needs* book last year heightened awareness that human capital is our most precious commodity. But perhaps the greatest antipathy will be evoked by the introduction of the Construction Industry Transformation Charter³. In a few days this document will be adopted and our industry will never be the same again.

The imperative to transform finds expression in various ways in the unique circumstances that countries face. From the Bumiputras of Malaysia to the minorities of the USA, from Australia's aborigines to an evolving Europe, local and regional peculiarities require special interventions to correct imbalances. In South Africa we must deal with racial inequity

³ Construction Sector, Broad Based Black Economic Empowerment Charter, Version 6 (Final)

The Broad Based Black⁴ Economic Empowerment (BBBEE) Act has, at its core, the need to change the South African economic landscape through growth and transformation. This has been progressing since democracy (and in some senses even before), but the threshold it now crosses is to broaden the focus from black ownership alone, to the seven elements of empowerment.

At a broad, strategic level the Charter provides qualitative commitments by the industry to achieve certain transformation objectives in four to seven years. At a quantitative level, the accompanying balanced scorecard provides for specific measurements against predetermined targets for various categories of black empowerment.



Previously, black ownership was the primary (generally the only) criterion considered. When coupled with poor verification, this single-channel approach left the way open for fronting. By contrast, the nature of broad-based empowerment is such that every enterprise becomes both an implementer and facilitator of economic transformation.

The figure shows the major components and their weighted contribution to an enterprise's scorecard.

It is envisaged that this intervention will create a pipeline of "black" individuals and enterprises to right the skewed distribution of power, influence and prosperity in the economy. It achieves this through corporate social investment in previously disadvantaged communities, and direct and indirect empowerment of black individuals and enterprises.

In the medium to long term the Charter will encourage black participation at all levels economically, technically and managerially. In this way the capacity and competence of the entire construction sector will be elevated over time. Ultimately this should lead to the construction sector becoming a more inviting investment destination to the benefit of all who are involved in it.

I was privileged to be closely involved in the Charter process. It highlighted to me the profusion of industry stakeholder organizations and, paradoxically, the paucity of leadership in these organizations. Each industry event presents an opportunity for the same individuals to simply change hats and take their usual seats at the table, and the usual litany of absenteeism. How successful can change be when only a handful of people are continuously engaged?

And yet, I was fascinated by the dynamics of the negotiations. We have seen the same pattern in the reactionary responses to other changes in our sector. The classic response to loss⁵ (in this case the loss of control and privilege) was and, in some quarters, remains evident:

1. Denial - *There's no way that this will work, they will see the folly*

⁵ Kubler-Ross (2000, 2003)

- of their suggestions and things will go back to normal.*
2. Anger - *How much more do they expect us to take!*
 3. Bargaining - *Okay, be reasonable about these targets. Don't make them unachievable or nobody will be willing to participate.*
 4. Depression - *It's going to be so difficult to achieve. We'll go out of business.*
 5. Acceptance - *Maybe if we put this or that plan in place we'll be able to get some competitive advantage out of this yet.*

Although the Charter targets are, in my opinion, far from bold or audacious, the agreement itself remains a significant achievement. It once more demonstrates the interdependence of the various players: client and service provider, contractor and consultant, architect and engineer, and so on in an infinite web of interaction. It also provided a glimpse of the South African construction ecology.

*Construction Ecology*⁶

Although the concept of ecology and ecosystems are usually applied to the environment and biosphere, I am using the reference in a broader context, in the sense of the interdependence of all phenomena in nature. And we are all part of nature.

The pervasiveness of interconnections in the universe is attested to not only by spiritualists like the Dalai Lama, but also by great physicists like Albert Einstein and Werner Heisenberg, environmentalists like James Lovelock and economists like Manfred Max-Neef. Indeed, science had to develop quantum physics in an attempt to describe occurrences at sub-atomic level, only to discover that there are no elementary particles, no basic building blocks from which the universe is created. As Capra suggests, it is more reasonable to consider the universe as a “dynamic web of interrelated events”.

If poverty and prosperity are both properties of an ecological system, how would we characterize a healthy and sustainable construction ecology? I will describe five of the essential components:

Networks

Construction systems nest within each other to form the overall construction ecosystem. Think of the various professions, constructors, suppliers of material and financial resources. The boundaries are soft, signifying identity rather than separation. As living systems, they communicate with one another and share resources like people, materials and technology across these boundaries. They are clearly mutually dependent and must behave accordingly.

Cycles

Life requires energy and matter to subsist, and waste is produced. Natural ecosystems, though, generate no net waste the output (waste) of one part being the input (food) of another. Renewable energy and this continuous cycle of resources sustain growth. At this stage, however, economics encourages construction to be a linear, wasteful system because the real cost of waste is not factored into production.

⁶Capra, 2002

Partnership

In prosperous ecosystems, cooperation and collaboration, not competition and conflict, distinguish the relationship between participants. Resources are shared. Coalitions for improvement spontaneously develop, and the ecosystem sustains and prospers. Individual and collective empowerment and development are accepted as central values. Dominance is temporary.

Diversity

Resilience and stability are achieved through the richness of the diversity in the system. Single species ecosystems are fragile because of the catastrophic impact of threats to that species. People of different genders and race and of various political and religious persuasions are encouraged to participate because it is good for the ecology. Differences are characterized by recognition, and not separation or friction. In this way innovation is nurtured.

Dynamic Equilibrium

The environment is not static, but the responses to variation are nimble and continuous because of the excellent communication and feedback throughout the system. Rather than maximization of any single outcome, continuous optimization maintains equilibrium. It is only through a realization of how problems are related that sustainable solutions can be pursued. This is simply not possible if operations occur in hierarchical silos.

All of these components must be satisfied for prosperity. Even as we construct an ecology for our sector, we must recognize that it sits within a broader ecology. It is this ecological approach that gives appeal to the views of the Chilean economist Manfred Max-Neef. It is consistent with his description of fundamental human needs that are neither hierarchical nor sequential but interrelated.

Human Development Theory suggests that all the basic human needs must be fulfilled for sustainability: subsistence, protection, affection, participation, leisure, creation, identity and freedom. Engineers have considerable influence over the satisfaction of these needs.

We are obliged to fundamentally review our patterns of work and organization to address the challenges of poverty and inequity. Procurement, transformation, human and organizational development must turn away from a purely competitive and compliant mindset to the paradigm of ecological sustainability characterized by cooperation and mutual development.

People take us there

Recent research⁷ by Ms Allyson Lawless (SAICE President 2000) emphasized our precarious limitations in engineering human resources, in capacity, capability and equity. It revealed that the capacity and competence of the industry has been severely affected by the lack of suitably qualified and experienced engineers in the age groups from the late twenties to the early fifties. Engineers older than this are almost

⁷Lawless (2005)

There are two separate languages now - the language of economics and the language of ecology, and they do not converge.
- Manfred Max-Neef

entirely from the white group and new entrants to the industry are overwhelmingly black, particularly at technician and technologist level. This suggests that one of the key bottlenecks to development will be the lack of suitably qualified engineers in the public and private sectors. Making training a requirement for the Charter encourages exactly the type of transformation intended by that process.

Clearly, the effects of unfair discrimination are not past. The low numbers of black matriculants with mathematics and science on the higher grade (less than 1%) is proof of this. Combine this with low levels of funding for academic institutions, decreasing rates of graduation from universities of technology, the poor pay levels of engineers and lack of capacity to mentor and coach those that successfully emerge, and we have the reasons for our present dilemma. Of course, affirmative action has played a role, but I believe this to be exaggerated. The greater risk lies in the tendency for schools to encourage standard grade maths or dropping of the subject altogether so that a higher overall pass-rate is achieved. The pipeline of engineers is being effectively squeezed to a trickle, a situation that South Africa cannot afford.

The power of relationships

Earlier I stated that South Africa must address the challenge of racial inequity. The past ten or twelve years in South Africa have been a time of frenetic legislative and regulatory reform, much of it directed at this challenge. If we look at construction alone, dozens of new pieces of legislation and regulation have a direct impact on business activity. How much thought is really given to the impact that these laws have on each other let alone on the intended targets? Do they all pull in the same direction or do they dissipate rather than redirect energy? Intervention might be necessary to correct imbalances but, as in any ecosystem, it can lead to unintended consequences.

We have become slaves to mechanistic thinking through centuries of adherence to the Cartesian method. We have a tendency to value specialisation and understanding of detail through progressively dissecting any problem into ever smaller parts. We assume that if we can break it down far enough and we can understand the basic components, then we will be able to understand the overall structure. We create blinkered laws and institutions as a consequence. However, human behaviour and organisational structures are complex. The relationships between the parts are as important as the parts themselves.

Quantum physics explains that there is no objective reality in nature. Context, and not content, is the key to understanding. Indeed, at sub-atomic level many particles have no mass at all and effectively only exist in relationships.

There is an old Sufi teaching that says, "You think that because you understand *one* you must understand *two*, because one *and* one makes two. But you must also understand *and*". In the misguided search for simplicity, our relentless dissection discards the relationships and thereby reduces its meaning.

What lies ahead

Ladies and Gentlemen, the metric system was devised to facilitate communication between scientists, engineers and administrators and ultimately to transform the world into a free market for the open exchange of goods and information. It was a prerequisite for globalization. Consider the elegance of the length, volume and weight relationship: a cubic metre holds a 1,000 litres of water, which weighs 1,000 kilograms, and a metre relates directly to the ground beneath our feet: it is the distance from the North Pole to the equator divided by 10 million. What could be simpler?

Except that the metre is not a ten millionth of the quarter meridian. You see, during the survey, one of the astronomers, Mechain, discovered an error in his calculations and covered it up! All subsequent definitions of the metre retained this error, even after it was exposed. One might say that this was an error for all people for all time.

Engineers can easily identify with standardization - it relates to order and control. But standards are invented - they only give us the illusion of control. We should adopt them when necessary, but we should not elevate them to the status of truth. From satellite surveys we now know that the length of the quarter meridian equals 10,002,290 metres. So the metre that we use today is out of "true" by 0.2 millimetres, or the thickness of two pages. It does not matter. It has not hampered engineering. In this regard accuracy is not as important as a common vision.

Incidentally, the metric reformists had also proposed other standards:

- Time would be standardized to a decimal system of ten hours per day, with 100 seconds to a minute and 100 minutes to each hour. But this was rejected because of the cost of changing all the nation's clocks!
- A working week was to be ten days but for understandable reasons workers refused to accept this symmetry!

Not all of the proposed changes were adopted. We don't have the 400 degree circle, and a degree of latitude is not 100 kilometres, but we do speak a common language of measurement.

History has much to teach us. Perhaps the appeal of true stories lies in the notion that we are all sequels - son/daughter of so-and-so. At the same time we are all prequels. Whether or not we have children ourselves, the world is never the same for us having walked through it. Writing is very limiting. It is essentially linear, especially when in the form of technical reports, and so constrains our ability to communicate complex ideas and concepts. Stories on the other hand are not. They draw reference from our memories and create anticipation of what's to come. In doing so, they place development in context. And so, I look forward to the work of the newly established History and Heritage Panel at SAICE, and hope that it will inspire the newly inducted as it records our past achievements.

Engineers make good problem solvers, yes, but too often we do this in

In 1960 the metre was redefined as 1,650,763.73 wavelengths of the orange red line in the spectrum of the krypton 86 atom. Finally in 1983 the metre was redefined as the distance that light travels in a vacuum in $1/299,792,458$ seconds with the time defined by an atomic clock.

It is said that in his later years the great Leonardo da Vinci scribbled across his canvases "Di mi se mai fu fatta alcuna cosa": Tell me if ever anything was finished?



*The 10 hour clock midday is 5 o'clock and midnight at 10 o'clock.
- Musee des Arts et Metiers, Paris.
Photo: Pascal Faligot*

the mechanistic way of Newton and Descartes that loses sight of the bigger picture. These mechanistic approaches permeate every aspect of business, from environmental management to construction processes and from organisational development to empowerment. One consequence is the dehumanisation of our world. The challenges of poverty and the satisfaction of fundamental human needs loom over us all. The past year has also been one of terrible natural disasters from tsunamis to earthquakes. Being spared should not make us complacent. At SAICE we will continue our work with Engineers Against Poverty and engage with the newly formed SA Chapter of RedR (Engineers for Disaster Relief) to contribute and prepare ourselves better for such events.

To suggest that a cultural change is required in order that people behave differently is absurd. We should begin to act in a manner that is effective because this will change behaviour and hence a new culture will emerge. The construction sector has almost always been reactionary to official policy, perhaps because of its long season of decline. Unless we begin to lead effectively we will be led, with little opportunity to influence the choice of path.

Representing as we do engineering professionals from all sectors of the economy, SAICE is well connected and has broad credibility. In an under-resourced industry, we cannot afford waste. We will increase our work with the networks of industry stakeholders to find greater synergy and efficiency of resources. For the first time, SAICE and the Association of Consulting Engineers will coordinate branch visits. My counterpart, Webster Ndodana and I will visit at least three regions jointly this year.

Life is no metronome, continuously ticking with a regular beat, without variation in tone or pace. It is more like jazz, an infinite number of melodies expressing themselves individually, only requiring you to pick one out to enjoy it. And then they come together to harmonise - and you have ecstasy. SAICE is uniquely placed in an industry of separate melodies. We have members from every fragment - black and white, male and female, young and old, constructor and consultant, client and service provider. We will increase our efforts at facilitating harmony within this wonderful diversity. We will promote a balance between these melodies - not only for the sake of disadvantaged black people and women, but for the sake of the resilience of our industry.

Hierarchy and roles are not as important as potentialities. SAICE has for some time played an important role in influencing and executing training for the construction sector. As an independent learned society we are specially positioned to comment and advise on these matters. This year we hope to commence a study towards publication of a State of the Nation Assessment of Infrastructure. Our revised structure will enable us to increase our efforts and effectiveness to the benefits of our members and all industry stakeholders through career guidance at schools, training, capacity building and meaningful engagement with all tiers of government.

Final thoughts

I have proposed that continuous change is essential for progress and for growth. We are a living ecosystem that must change to prosper while staying true to ourselves. We require a strong sense of identity, worth, and purpose that create stability in a dynamic environment, one that promotes self organizing rather than that dictated by form or function, for these are transient concepts.

As engineers we tend to think that anything that cannot be pinned down to an equation or an observation converted to an empirical standard is not worthy of contemplation. Our western approach to individualism, competition and a mechanistic worldview combine to render us prisoners of an endless procession of organisational change, fads and new ideas. True leadership is not about imposition or control. It lies in the ability to explore possibilities; of remaining flexible and nimble; in welcoming chaos and disorder and developing dynamic equilibrium. We need to hold our attention to two levels simultaneously, the part as it relates to a whole and moving in between the two at the same time in a continuous dance. Too many of us would agree with Lenin when he said, "freedom is good but control is better". Order and control are temporary concepts, if anybody we South Africans should know this well. Growth is a result of a beautiful dance between order and chaos, between freedom and control, between confusion and enlightenment.

All development whether schools for education, clinics for better health, shelter, sanitation, potable water, financial and telecommunication services, in short everything we see - is leveraged off economic infrastructure. In turn, all infrastructure is leveraged off the human capital we call engineering professionals. So in a very direct way we are responsible for the social and economic health of the nation.

I have a picture on my computer desktop that keeps me honest. It's a simple scene at first sight: a young scholar, in immaculate uniform, seated. On an open toilet. In the open air. In full view of the photographer. Unconcerned? No! The child is no more than 10 years old, but old enough to know the meaning of dignity. This he attempts to achieve by covering his body as much as he can while performing his biological functions. He looks at a moderately trafficked road, out of picture, with the shine of sunlight on his face. Is it the Age of Hope he sees? Perhaps of engineers who might remove the indignity? Will we fulfil that hope?

In closing, allow me to paraphrase his holiness, Tenzin Gyatso the 14th Dalai Lama:

Just as the world of business has been paying renewed attention to ethics, the world of (engineering) would benefit from more deeply considering the implications of its own work. (Engineers) should be more than technically adept; they should be mindful of their own motivation and the larger goal of what they do: the betterment of humanity.

Thank you

Dedication

I dedicate this address to friends and family who, with love, have nudged my life into its many interesting twists and turns. Most of all, I dedicate it to my parents who taught me perseverance, brother and sisters for their unquestioning support, children Shaista and Shiraz who opened my eyes to wonder, and my wife Lekha who has been my strength. Your love sustains me.

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The ·South ·African ·Institution ·of ·Civil ·Engineering



Private Bag X200 Halfway House 1685. Tel: +27 11 805 5947 Fax: +27 11 805 5971
E-Mail : civilinfo@saice.org.za Website : www.civils.org.za