THE ECOLOGY OF CONSTRUCTION

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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 priviledge.

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, leadership and, on occasion, social comment – sometimes bravely. My intention tonight is to present a new view of the construction sector. I will speak of "The Ecology of Construction" - or the complete and fundamental interconnectedness of individuals, organizations, resources and processes in the construction sector.

ecology: *study of the relationships between organisms and their environment*

I suggest that we define our environment and our future by the way we embrace continuous change: in an ecological, rather than a mechanistic manner.

Engineering professionals[1] 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 and logical; to seek solutions in the face of challenging problems. So our language tends to be dry, precise, 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. Measurement seems to be everything. We find this much easier than expressing emotion and passion.

As an industry, we must strive for continuous improvement in delivery, quality, safety and prosperity. 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, we are required to interact at a human, not technical, level and to persuade, not simply specify. And we cannot convince through data alone.

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 relate a tale about measurement and global transformation. For the next few minutes, relax and allow yourself the luxury of

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

traveling with me… in space … and time. We are in France in the late 18th century, when life is conducted at a gentler pace.

Every town and village, it seems, has its own standards for length, weight and so on. We're now standing outside the town hall of Laon. The T you see mortised into the wall is the standard measure for the size of barrels. The smaller rectangle is for bricks and the larger one below it for roof tiles. The bar is an *aune* – a length measure for timber or cloth and is about 3 feet in length. Of course these measures are not constant in our town, nor are they identical to the measures in the neighbouring towns. It's the 1780's, and France alone has more than 250,000 units of measure for length and weight!

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.

Of course we don't yet know about trains or cars or planes, so most people don't get around much. The general populace sees little advantage in uniform standards, but for us engineers this profusion of standards is a disaster. It hinders proper communication within our country and with other nations. So, the *savants,* the French intellectuals in the Academy of Science, decide to change this by agreeing a universal standard of measure – we will call it the *metre*.

But what would we use as a measure that would receive widespread approval. One option is 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? Not likely!

Using the Earth as reference is logical as it belongs to all people, but which reference line to choose? The equator is unique, but most of it traverses ocean or inhospitable lands. It is also inconveniently far away from France and Europe. After much discussion, we decide 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. Also, providence has blessed France with the meridian through Paris – it also passes through Dunkerque on the North Sea and Barcelona on the Mediterranean[2]. It is perfect for the task.

On 24 June 1792, King Louis XVI authorizes the "Meridian Expedition[3]". Two of France's best astronomers, Joseph Delambre and André Méchain (the

[2] To accurately extrapolate the length of the quarter meridian, a portion must be surveyed by triangulation and a "baseline" physically measured. Also, the start and end points must be at sea level. Part of this meridian had previously been surveyed.
[3] Alder (2004) provides a fascinating account of the Meridian Expedition

latter from the town of Laon), set out on an expedition to survey the meridian and so define the metre.

Did I mention that we're in France in the 1790's? At about the same time, in South Africa the frontier wars are being fought in the Eastern Cape, the US constitution has been adopted, and resistance to slavery is growing everywhere. In England the rules for cricket are drawn up by the MCC, and the first group of convicts is delivered to a place to be named Sydney!

In France itself, the Declaration of Human Rights is adopted, the monarchy is deposed and the French Revolution is well under way. Democracy has arrived and the peasants are liberated. Just months after approving the Meridian Expedition to define the metre, Louis XVI loses his head to the new invention: the Guillotine, and the countryside is in chaos. Instead of a few months, the meridian expedition takes seven years, a period that includes Wars between France and Prussia, Britain, Spain, Egypt and Italy, and the rise of Napoleon Bonaparte. It is a time of political and social upheaval.

Despite the chaos, the length of the metre is calculated precisely and, returning to the present, we know it has become the international standard, with all but one economic power embracing its convenience.

I will return to the story later. This was the first serious attempt at standardization and it revolutionized engineering. It happened two hundred years ago. But let's ask ourselves: was this not a sensible intervention? Why did people not embrace the change so that it could happen quicker and less painfully? Can you imagine the potential for disaster if the channel tunnel was constructed with two sets of measures for France and the UK?

*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.*

Well that's exactly what happened when NASA launched 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. Today, the only notable recalcitrant from this system is the world's superpower, USA, and even there an insidious process of change is underway.

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. Set in the context of poverty and unemployment, it is faced by the challenges of globalization, racial and gender transformation and steeply increasing demand.

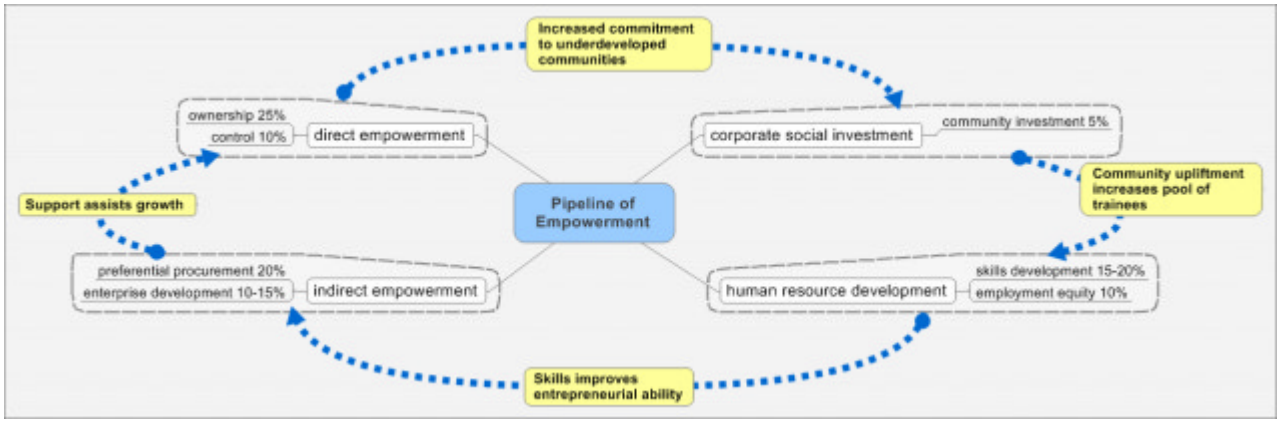
If ever there was any doubt, SAICE's publication of Allyson Lawless's *Numbers and Needs* book last year heightened awareness that human capital is our most precious commodity.

The effects of apartheid are not past. There is a severe shortage of black and women engineers in the age group from the late twenties to the early fifties. Engineers older than this are almost entirely white males and new entrants to the industry are overwhelmingly black, particularly at technician and technologist level. We see it also in the low levels of black matriculants with maths and science. In South Africa and Africa the ratio of engineers ranges from 1 in 3,200 people to 1 in 15,000. By comparison, the range in Europe, America, India and China varies between 150 and 300 persons per engineer!

The Construction Industry Transformation Charter[4] will be adopted in a few weeks 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 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.

The Charter has, at its core, the need to change the South African economic landscape through growth and transformation. The threshold it now crosses is to broaden the focus from black ownership alone, to the seven elements of empowerment.



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

[4] Construction Sector, Broad Based Black Economic Empowerment Charter, Version 6 (Final)

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. Think of it this way: corporate social investment (CSI) in previously disadvantaged communities increases the pool of potential trainees; provision of training makes these people more employable; affirmative selection contributes to improved entrepreneurial ability; preferential procurement and enterprise development initiatives increase the management and control potential, and this promotes ownership by black people. The cycle is completed by increased CSI because the persons at the top see the relevance in this investment. This evolutionary, multi-faceted approach is a more sensible and natural intervention.

Although the Charter targets are, in my opinion, far from bold or audacious, the agreement itself remains a significant achievement. It was a process that also provided a good picture of the South African construction ecology. How will we approach the challenges that it presents? In our typical way of war – poaching, fronting and competing, or through a more – let's call it ecological way of cooperation?

Construction Ecology

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 environmentalists like James Lovelock, economists like Manfred Max-Neef and great physicists like David Bohm, Albert Einstein and Werner Heisenberg. 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".

Poverty is undoubtedly our greatest challenge. If poverty and prosperity are both properties of an ecological system, how would we characterize a healthy and sustainable construction ecology[5]? I will suggest five of the essential components:

The first is 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. Think of the various caucuses: black and white, women in construction, emerging and established. The boundaries between them 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. We must ask: do our networks seek to exclude for self gain rather than share for mutual good?

[5] I was inspired by Capra (2002) in providing this description.

The next component is 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. Do we encourage production systems that are wasteful and corrupt? Because corruption is nothing other than waste.

The third component is Partnership
In prosperous ecosystems, cooperation and collaboration, not competition and conflict, distinguish the relationship between participants. Resources are shared. Coalitions for improvement develop spontaneously, and the ecosystem sustains and prospers. Individual and collective empowerment and development are accepted as central values. Dominance is temporary. Are we in relationships of growth or of exploitation – often under the guise of "that's business"? Do we see that our wild compulsion for competition is not desirable especially in our low resource environment?

The fourth component is 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 single species. Differences are characterized by recognition, and not separation or friction. In this way innovation is nurtured. People of different genders and race and of various political and religious persuasions must be encouraged to participate because it is good for the ecology. We need black people and women in engineering not for their sakes, but for ours!

The final component is Dynamic Equilibrium
The environment is not static, and new challenges are constantly encountered. The responses to variation must be nimble and continuous through 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. The Charter's multi-dimensional approach is a good example of optimization, but how will it be applied? How much thought is really given to the impact that construction 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.

All of these components must be satisfied for prosperity. Even as we describe an ecology for our sector, we must recognize that it sits within a broader ecology. If we are to address the challenges of poverty and inequity, we must replace our purely competitive and compliant mindset with the paradigm of ecological sustainability characterized by cooperation and mutual development.

What lies Ahead?

Ladies and gentlemen, the metric system was devised to facilitate communication. It was a prerequisite for globalization, whatever your view on that concept. Consider its elegance: 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, Méchain (our friend from Laon), 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.

In 1793 the metre was defined as 1/10,000,000 of the quarter meridian.

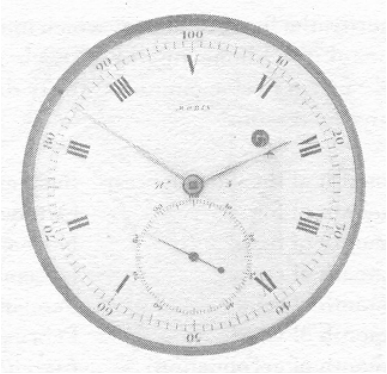
In 1960 the metre was redefined as 1,650,763.73 wavelengths of the orange red line in the spectrum of the krypton 86 atom.

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?

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. We must see all standards and regulations in this light. 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 "truth" is not as important as a common vision.

Incidentally, the metric reformists had also proposed other standards:



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

- 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. (Had it been adopted, the metric day would have fewer hours but more seconds - 100,000 compared to the present 86,400.) 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!
- A circle was to have 400 degrees, so a right angle would be 100 degrees and a degree of latitude would equal 100 km.

Not all of the proposed changes were adopted, but after two hundred years we do speak a common language of measurement. Well, apart from the USA…

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. 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 our present development in context. And so, I urge you to tell stories, relate rather than report, and I look forward to the work of the newly established History and Heritage Panel at SAICE. I hope that it will inspire the newly inducted as it relates our past achievements.

Engineers make good problem solvers, yes, but too often we do this in the mechanistic way of Newton and Descartes that loses sight of the bigger picture. We have misplaced the value of specialisation and believe that understanding only comes 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. As a consequence we create blinkered laws and institutions.

However, human behaviour and organisational structures are complex. The relationships between the parts are as important as the parts themselves. I try to bear in mind the 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 the meaning of life.

Another consequence of this dissection behaviour is the dehumanisation of our world. The ecological approach 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.

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

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 and floods 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.

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 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. As an example, for the first time, SAICE and the Association of Consulting Engineers will coordinate branch visits. My counterpart at SAACE, Webster Ndodana, and I will visit many 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 or what jazz artists call "being in the groove". 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.

As an independent learned society SAICE is 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. We will increase our efforts at career guidance at schools, training, capacity building and meaningful engagement with all tiers of government. In short, we will look at networks to encourage interdependence, and at cycles to reduce waste in our industry. We will seek to strengthen partnerships for mutual development, encourage diversity towards greater innovation and resilience and seek continuous optimisation to achieve dynamic equilibrium.

Final thoughts

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 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. Our western approach to individualism, competition and a mechanistic worldview militate against a natural ecological approach. It is easy to forget the importance of what we do.

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. In the open air. In full view of the photographer. On an open toilet. 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[6] he sees? Perhaps of engineers who might remove the indignity? Will we fulfil that hope? What is our role?

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

> *…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[7].*

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.

[6] Reference to President Mbeki's State of the Nation address at the opening of Parliament, 2006.
[7] Gyatso (2005)

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