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Civil Engineering | September 2008 1
The secret of the successful career and continued activities of Graham Lindsay Drury Ross lies at least in part in being extraordinarily well organised, focused and hard working. The sheer volume of his technical writings and documentation about topics such as transportation in Namaqualand, the history of Cape mountain passes and geometric design – produced in part while he was still practising as engineer, but largely also after his retirement in 1993 – would be a daunting undertaking for most people. But if one then realises that one of the volumes happens to be the dissertation which earned him his PhD in Transport Studies from the University of Stellenbosch at the age of 74, one begins to understand that the author is someone of rare quality.

Dr Ross’ output as author started in the 1960s with his Master of Science thesis entitled Direct Evaluation of Left-hand Ramp Operation (Northwestern University, 1963) and continues until today. He has written numerous articles for various publications on a range of topics and is particularly well known for his writings about Cape mountain passes and the history of transportation in Namaqualand.

A collection of 18 articles first published in Civil Engineering, entitled Reminiscences about Cape Mountain Passes, was published in 1998. These reminiscences also lead to the book The Romance of Cape Mountain Passes, which was published to mark the 100th anniversary of the founding of the South African Institution of Civil Engineering (SAICE) in 2003, and which describes the history and engineering achievements of 31 of the best-known
Graham’s own practical experiences in Namaqualand became an enduring interest. Methodical research into the history of and issues relating to transportation engineering lead to numerous articles and papers, culminating in more comprehensive and scholarly publications.

Namaqualand: A Transportation-related Chronology and its companion volume Namaqualand: An Annotated Biography were both published for limited distribution in 1996. Ultimately the research done for that documentation allowed him to turn the material into “something more academic”, leading to the dissertation entitled The interactive...
role of Transportation and the Economy of Namaqualand, which earned him his doctorate.

Subsequently he published a limited edition of another scholarly documentation: Mountain passes, Roads and Transportation in the Cape: A Guide to Research (2004). Always methodical, he kept a careful record of the whereabouts of all 50 printed copies and says that when those ran out, he started “dishing it out on CD”. Over the years his output in the form of articles for Civil Engineering has continued. Particularly notable have been the collection of articles Reminiscences of a padmaker and a series of articles written or co-written on Past Masters.

He continues to write articles and present papers and is currently busy on another book. This edition of Civil Engineering again contains one of Dr Ross’ articles, entitled “The earliest South African road bridges outside of a town” (page 37).

Studies
How did his PhD – at an age when most people are no longer interested in academic study – come about? “I always wanted to do a PhD,” he says, “especially after I had completed my Masters degree in Transportation Engineering at Northwestern University (Illinois, USA).” He says he did not really enjoy his BSc studies because it was a “hard slog” – among others because it was interrupted by his service in the Navy during the Second World War. This service had taken him to countries bounding the Indian and Pacific oceans and he had risen to the rank of sub-lieutenant before he left the Navy and could continue his studies for his BSc at the University of Cape Town.

After some years working as engineer for the Cape Provincial Roads Department, an opportunity came to Graham for advanced engineering studies. Dr Don Berry, who had been presenting a six-week course organised by the SA Road Federation at the University of the Witwatersrand, invited him to do the Masters degree at Northwestern University in the US. He jumped at the idea because it was a “meaningful opportunity – and also a rare one in those days”. It was hard work under difficult circumstances: at the time he was the 36-year old father of two young children and most of his classmates were younger by a decade or more. As a matter of fact, he adds, “during that whole period I took only one Sunday off, but it paid off because I learnt so much there and got the degree!” He heaps praise on his wife Eileen “who always backed me up even when we had no money when we started out. In America she not only looked after the children in our single room apartment in Evanston near Chicago for 1½ years, but also typed up my homework for me.”

Could he have continued his studies in the US after completing the MS degree in 1963? “Yes, Professor Charles Pinnell offered me the opportunity of becoming a research at Texas A&M University while working towards my doctorate, but I had promised Province I would come back after the Masters,” he says simply.

However, the desire to complete a doctorate remained and many years later he realised the substantial amount of research work done during the writing of the chronology of engineering in Namaqualand could be converted into a scholarly work. He was given the go-ahead to work on a doctorate on the subject at Stellenbosch University and in December 1998 he was finally awarded his PhD.

Career history
After completing his BSc degree in 1948, Graham started work at the Cape Provincial Roads Department. In the beginning, he “learnt by doing,” because his training at university had been very general. He says “the people at the Department were wonderful and had various training programmes to teach you about practical engineering.” He hoped to stay near the ocean, among others so that he could continue sailing – but soon found himself far away from the sea in Namaqualand – an area about which he knew nothing at the time, but which he clearly still has a deep affection.

His first major assignment was to work on the construction of the road between Okiep and Nababeep, which was the first black-top rural road in Namaqualand. More responsibilities followed, and three weeks before his marriage to Eileen he received a telegram (he was stationed at Oudtshoorn at the time), transferring him to Kimberley as District Roads Engineer. Graham says that he looks back on his six years in Kimberley District as the most satisfying of his career. During his last years at the Cape Provincial

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The South African Institution of Civil Engineers
Division of Highway and Traffic Engineering

the Chairman's Award
for Meritorious Service to the Transportation Engineering Profession – received from the SAICE Division of Highway and Traffic Engineering

Graham Lindsay Drury Ross

1993 March

Roads Department, he worked as Geometric Design Engineer.

In 1967 he joined Ninham Shand Consulting Engineers as senior engineer and progressed to partner and director. From 1978 to 1980, the partners at the firm permitted him to serve as President of the South African Road Federation. He retired as a Director in 1983, but continued working as a Consultant for the next ten years. "Being a consultant was almost like having a holiday, because I could concentrate purely on engineering, without staff or administrative responsibilities," he smiles.

Since his retirement from Ninham Shand in 1993, Graham has devoted much of his time to research and writing. He says that "I can really do the research now that I have done the engineering." He tells how his love of caravanning has often been combined with doing research. "I travelled around the country talking to people."

Talking about his research into a number of topics, makes one wonder whether he ever considered a career as academic. He says that he did receive at least one offer, but did not take it up, because at the time he was particularly enthused by geometric design and wanted to do more in that field. He tells how in 1957 the geometric design manual for the Cape consisted of one single page. During the 1960s, the "second great road-building era in the country", the need for geometric design became more clear – the many freeways and interchanges that were being built, necessitated advanced skills and techniques, including geometric design. In the 1960s he started compiling a geometric design manual for the Cape (the first in the country) and continued to add to it until he left Province to join Ninham Shand.

Honours and recognition

Graham Ross is a past Chairman of the SAICE Western Cape Branch, has served on the Council of SAICE, and has been a chairman or member of many other professional and environmental committees. He was awarded the SAICE Division of Highway and Traffic Engineering Chairman’s Award for Meritorious Service to the Transportation Engineering Profession in 1988, was elected an Honorary Fellow of the chartered Institute of Transport in South Africa in 1992, and of SAICE in 2001. After serving as President of the South African Road Federation, he was made Honorary Life Member in 1980 and Honorary Vice President in 1987.

In addition to local recognition, he was awarded Queen Elizabeth’s Coronation Medal in 1953 for services in the roads field, and in 1962 had the honour of being elected an Associate Member of the Society of Sigma Xi, USA. From 1976–1978 he was a member of the International Advisory Committee of the Institute of Transportation Engineers and represented South Africa on the International Council of that Institute from 1986–1988.

Graham on civil engineering today

Asked about the major challenges for road engineering in South Africa today, Graham highlights the lack of funding for maintenance: roads are slowly deteriorating and the cost of repairs is escalating very fast. “A penny of prevention is worth a pound of repair – but funds for maintenance funding are too limited,” he says. “Of course this is part of a complex situation relating to transport and other infrastructure, as well as issues such as social development and urbanisation.”

What advice does he have for young engineers starting out today? “Go to where you see that people are enthusiastic. Consciously look for that kind of organisation – don’t go somewhere where people just work for their month-end cheque!” he says. In terms of academic qualifications, his advice for young engineers who have just completed their BSc studies is that it is often better to "work for a few years and discover which particular branch of civil engineering you really like before deciding on the field for your master’s degree."

Gracious host

During the course of the afternoon my gracious host had prepared tea, patiently answered my many questions, and helped me to understand more about some of the history of civil engineering in South Africa, about the role of civil engineers in society and much more. Sadly, his wife Eileen was indisposed, but the family cat Bonnie did walk in to introduce herself to me. Graham and Eileen have two sons, Douglas and Alan. Douglas is a computer expert while Alan is a hydrographic surveyor.

I felt enormously enriched after an afternoon in the company of this humble yet highly accomplished padmaker – a simple word which Dr Graham Ross himself has elevated to a term of nobility.

Talking about his research into a number of topics, makes one wonder whether he ever considered a career as academic. He says that he did receive at least one offer, but did not take it up, because at the time he was particularly enthused by geometric design and wanted to do more in that field.
Very visible, and extensive in its scope and scale, the GFIP is an exciting project that, once completed, should immediately and positively affect the lives of most people living and working in Johannesburg and Pretoria. Whereas other huge, award-winning projects often benefit only a few thousand people on a regular basis, the GFIP promises to contribute substantially to easing the daily lives of hundreds of thousands of motorists and passengers who currently spend many precious hours stuck in traffic. The official launch of the first phase of the GFIP happened on 24 June 2008 during a sod-turning ceremony at the Gillooly’s Interchange, one of Gauteng’s busiest interchanges. Work had started before the launch already, but has since taken off in all earnest. Motorists have become used to lane restrictions, concrete barriers and mounds of soil along their various routes to work and back, and are watching with interest the activities of the many tipper trucks, graders, backactors, water trucks and other construction vehicles at the side of the road or on the central reservation. This is indeed the stuff that little boys (who become civil engineers!) dream of.

AT THE LAUNCH OF the GFIP, the Minister of Transport, Mr Jeff Radebe, reiterated his belief that roads are the veins and arteries of the South African economy and that the GFIP would indeed serve as a ‘heart bypass’ for the economic hub of the sub-continent. It is expected that the GFIP would eventually contribute R29 billion to the Gross Domestic Product, and R13 billion to the regional Geographic Gross Product.

Considering that the 40-year old Ben Schoeman highway between Johannesburg and Pretoria carries more than 180 000 vehicles per day during peak periods, the implementation of the GFIP could not have waited one day longer. Under the GFIP extra lanes will be added to freeways and existing interchanges will be drastically improved.

Moreover, Intelligent Transport Systems will be introduced to manage traffic flow and to keep motorists informed of prevailing conditions. These systems include variable message signs, a Network Management Centre, ramp
metering, use of cameras, opening of auxiliary lanes, and so forth.

Open road tolling will be implemented towards the end of October 2010, comprising electronic tolling and the obligatory use of transponders in all vehicles. Roads of this high standard require the ‘user pay’ principle to ensure sufficient funding not only for construction, but also for maintenance and future development of the Gauteng road system.

Transportation engineers have repeatedly said that South Africa cannot afford to continue living by the ‘one person one vehicle’ concept of travelling. As the GFIP will also include high vehicle occupancy lanes, it should encourage the use of public transport, or the sharing of vehicles. This in turn would help to reduce the negative impact on the environment caused by too many slow moving vehicles.

As a creator of jobs, the GFIP will comfortably meet Government’s black empowerment targets, in that contractors tendered to allocate 41% of the total contract expenditure to SMMEs and/or BEEs. This equates to approximately R3.7 billion.
GFIP BROKEN DOWN INTO MANAGEABLE CHUNKS

The upgrading of 120 km of Gauteng freeways is being managed by the South African National Roads Agency Limited (SANRAL) in cooperation with the Gauteng Province and the three local authorities of Ekhuruleni, Tshwane and Johannesburg. The upgrading of the freeways has been organised into the following seven work packages:

- **Work Package A** involves the 17 km of road between the Golden Highway and 14th Avenue, and a further 1 km on the N12, between the Diepkloof interchange and the M1, towards the southwest of Johannesburg. The consultants on this section of road are the SNA and UWP-Nyeleti consortium, while the contractors are Siyavaya Joint Venture.

- **Work Package B** will deal with the northwestern and northern sections of the ring road, i.e. 21 km of road and interchanges on the N1 between 14th Avenue and the Buccleuch interchange. The consultants on this section are the Gauteng Freeway Consortium joint venture, and the contractors are GIF Joint Venture.

- **Work Package C** involves working on 23 km of the southern hemisphere’s busiest highway, the Ben Schoeman, between the Buccleuch and Brakfontein interchanges, with the consultants being BKS and the contractors GLMB Joint Venture.

- **Work Package D** covers the construction of work on a total of 15 km of road on the N1 between the Brakfontein and the R21 interchanges. The consultants on this stretch are Africon and DCA Joint Venture, with the Basil Read Joint Venture as contractors.

- **Work Package E** is situated in the
southeast, with 12 km of road on the N3 between the Old Barn and Geldenhuys interchanges and 4 km of the N12 between the Reading and Elands interchanges. The consultants on this section are the KAS Joint Venture SNA, and the contractors are the Siyavaya Joint Venture.

- **Work Package F** involves 17.6 km of the eastern section of the ring road, i.e. the N3 between the Geldenhuys and Buccleuch interchanges. The consultants are the Gauteng Freeway Consortium Joint Venture and the contractors GLMB Joint Venture.

- **The N12 upgrade** entails work to be carried out on 10 km of the N12 between the N3 (Gillooly’s) and the R21 interchanges, and the N3 section between the N12 and Modderfontein interchanges. Gillooly’s Joint Venture and CMC Joint Ventures are the consultants and contractors for these works. Construction of improvements on 27 km of the R21 and N12 will begin when the tender processes for these sections have been completed.

**TRAFFIC AND INCIDENT MANAGEMENT DURING CONSTRUCTION**

Well aware of the impact that GFIP construction would have on traffic management, SANRAL has developed and put into operation a comprehensive programme to minimise disruption and maximise road safety around construction areas.

One of the key elements of this plan is a sophisticated notification and information management system, seated in SANRAL’s Network Management Centre, where the impact of construction activities on freeways and interchanges is centralised and coordinated. The plan is designed to ensure the provision of timeous information to the public to enable them to make well-informed decisions before travelling on the freeway network. Details of road and lane closures can be accessed at www.i-traffic.co.za.

**GFIP contracts as per the various work packages**

Planned improvements to existing interchanges

- N1 William Nicol interchange
- N1 Allandale interchange
- N1 Rivonia Road interchange
- N3 Gillooly’s interchange
Planned improvements to existing interchanges

1. N1 Lynnwood interchange
2. N3 Elands interchange
3. Offloading concrete barriers at the Malibongwe interchange on the N1 south

DATE OF COMPLETION

Road works associated with the GFIP should be substantially completed by May 2010. However, if they are not completed by then, construction will cease for a period of three months for the duration of the FIFA World Cup 2010 event. The roads will be rendered serviceable for the duration of the event, and road works will then resume after the event.

INFO
Watch this space for follow-up articles focusing on the various work packages
THE CITY OF Johannesburg has adopted a spatial development framework which focuses strongly on the need to create a compact city and limit urban sprawl in order to utilise urban infrastructure and land more efficiently and effectively. The primary measure to support this policy is the Rea Vaya Bus Rapid Transit (BRT) system.

The principal project objective is to upgrade the quality and performance level of the public transport system. BRT refers to a high-quality, bus-based transit system that delivers fast, comfortable and cost-effective urban mobility through the provision of segregated right-of-way infrastructure, rapid and frequent operations, and excellence in marketing and customer service.

MAIN CHARACTERISTICS OF BRT
- Segregated busways or bus-only roadways
- Location of the busways in the median lane rather than in the kerb lane
- Existence of an integrated network of routes and corridors
- Separate stations that are convenient, comfortable, secure, and weather-protected
- Stations that provide level boarding between the station platform and the bus floor
- Special stations and terminals to facilitate physical integration between trunk routes, feeder services and other public transport systems
- Pre-boarding fare collection and fare verification
- Fare and physical integration between routes, corridors and feeder services
- Restriction of entry to the system to contracted operators under a reformed business and administrative structure
- Distinctive marketing identity for the system
- Use of low-emission-vehicle technologies
- System management through a centralised control centre, utilising Intelligent Transport System (ITS) applications such as automatic vehicle location
- Special physical provisions to ease access for people with special needs, such as children, the elderly and the disabled
- Clear route maps, signage and/or real-time information displays that are visibly placed within stations and/or vehicles

REA VAYA MEANS ‘WE ARE GOING!’
Rea Vaya is the name that has been chosen for the Johannesburg BRT system. It is a major contribution towards Johannesburg’s transformation into a world-class African city. This BRT system is one of the first of its kind in Africa (there is also a BRT system in Dar es Salaam).

Due to the legacy of spatial planning during apartheid, as a result of which the poor were forced to live furthest from their places of work, a large percentage of city residents, who do not have access to cars are still experiencing long travel times, with difficult transfers – mostly forced via the inner city.

The reason behind the city’s choice of BRT is that it combines the best features of rail with the flexibility and cost advantages of road-based public transport. It is also much quicker to implement than rail systems when faced with time constraints. BRT has been successfully implemented in many developing countries with transport problems similar to those of South Africa, such as Colombia, Mexico, Equador, Peru, Chile, China, Indonesia and India.

HOW WILL THE REA VAYA SYSTEM WORK?
Rea Vaya offers three inter-connected levels of service. The largest buses (those with a capacity of up to 90 passengers) will be articulated and will be referred to as the ‘trunk’ buses. These buses will travel only on the designated median lane trunk routes.

‘Complementary’ buses, which will be
able to pick up passengers at Rea Vaya stations on the trunk routes and will also be able to operate on the kerbside, will have a capacity of 60 passengers.

Finally, the ‘feeder’ buses (with a capacity of 32 passengers) will bring people from the outer areas which do not have direct access to the trunk or complementary routes. This will extend Rea Vaya’s network to areas far beyond the main trunk routes. When complete, Rea Vaya will cover more than 300 km of trunk routes across the city.

One of the most important aspects of this new system is that it will be fully integrated with other transport networks. Rea Vaya will not be competing with other transport systems such as the SARCC commuter rail system or the Gautrain. This is an urban transport network that will feed into and complement existing networks to ensure the most effective movement of people across the city.

The operator business plan has been modelled on successful BRT systems in Latin American countries where they have situations almost identical to those of South Africa, with large numbers of minibus taxis and buses vying for passengers, and where incumbent taxi operators and bus operators have become the new BRT operators. Rea Vaya operators will be compensated on the basis of vehicle kilometres run, rather than the number of passengers carried, and intensive consultation has been taking place with industry representatives – particularly in the minibus taxi industry. From the operational plan it is estimated that the direct operating costs will be covered by the fare income.

The estimated capital cost of Phases 1A & 1B amounts to approximately R2 billion, and the city has received a substantial proportion of this capital funding from the national Public Transport Infrastructure and Systems Fund (PTIS).

**BENEFITS OF AND CHALLENGES FOR THE REA VAYA**

Some of the short-term benefits are: efficient, reliable and frequent public transport services; affordable fares; a safe and secure public transport system; accessible public transport for people with disabilities and mothers with children; a decrease in traffic congestion, energy consumption and vehicle emissions; an enhanced urban environment; and recapitalisation of the public transport fleet.

The medium-term benefits are: containing urban sprawl (spread of settlements) and promoting densification; promoting social inclusion instead of isolation; and job creation.

The long-term benefits of the project are: economic development in and around the areas of operation; reduction in pollution; and a world-class public transport system that the city can be proud of.
There are however some challenges facing the implementation of a project of this nature, namely:

- Developing a robust business and financial model
- Obtaining buy-in from existing operators and financiers
- Training owners and operators in the skills needed for successful Rea Vaya operations
- Educating users and potential users
- Ensuring that the Rea Vaya system meets expectations, e.g. security, affordability and travel time savings
- Planning and implementing under time pressure

WHERE WILL THE REA VAYA BE IMPLEMENTED?

The City of Johannesburg is currently busy implementing Phase 1A of Phase 1 of the Rea Vaya BRT system. The full Phase 1, scheduled to be implemented by 2013, will be made up of 122 km and 150 stations.

PROJECT STATUS OF THE REA VAYA

The Johannesburg Development Agency (JDA) is involved in the physical implementation of the bus lanes and stations on 14 different contracts which are in various stages of preliminary design, detailed design and implementation.

An innovative design has been developed for the stations and these stations will be constructed off-site in a modular form. It is intended to have a prototype station placed next to Joubert Park in the inner city by the end of October 2008.

The Johannesburg Roads Agency (JRA) is involved in the implementation of the electronic components of the project – for example the fare system, the passenger information system and the global positioning system – and with the Rea Vaya Control Centre to be constructed in Martindale. This state-of-the-art Control Centre will feature composite ITS to ensure the smooth running of the BRT system, including facilitating and managing the day-to-day operations, scheduling and movement of the buses.

The selection of buses and engine propulsion systems is under way, with some 1 190 buses being required in total for Phase 1. These will consist of 427 articulated buses (19,5 m), 350 complementary buses (13,9 m) and 13 feeder buses (8,5 m).

A wide range of environmentally friendly propulsion options have been investigated, ranging from Euro 3 diesel and Euro 4 diesel to hybrid and ethanol-fuelled, and approval has been obtained for Phase 1A to be Euro 4 diesel using low-sulphur diesel. It is estimated that if only 15% of car users who live within 500 m of a Rea Vaya trunk route switch to Rea Vaya, some 370 000 tons of CO₂ will have been saved by 2010.

PLANNING FOR SERVICE DURING THE CONFEDERATIONS CUP

The Rea Vaya BRT system will be available to provide bus transport services for the Confederations Cup in June 2009. At present the project is concentrating on areas that will ensure that the BRT can provide services around and between the key soccer stadia in the city, namely...
Orlando Stadium and the Ellis Park Stadium. In addition, urgent attention is being given to satisfying the overwhelming need for enhanced public transport for commuters travelling from Soweto and surrounding areas into the inner city.

For the Confederations Cup, 143 buses, consisting of a mix of articulated (trunk) and complementary buses, will be in operation, travelling along a 25.5 km route network, and utilising 20 stations, with all buses and stations being fully accessible to people with disabilities. It is envisaged that the trunk buses will run one every three minutes during peak periods with a minimum frequency of three buses per hour during off-peak hours. The electronic ticketing system will provide a cashless prepaid fare collection system, minimising boarding delays and reducing Rea Vaya BRT travel time. It is estimated that during the Confederations Cup, the Rea Vaya BRT will be able to transport 69 300 passengers per day.

TOWARDS A WORLD-CLASS AFRICAN CITY
The Rea Vaya BRT project is of major importance to the development of Johannesburg as a world-class African city. It will have a profound effect on the movement of people within the city and on its growth patterns. It is also an important first step in implementing the national initiative to introduce Integrated Rapid Public Transport Networks (IRPTNs). This exciting initiative will change the face of Johannesburg and go a long way towards helping to integrate and transform the city.

INFO
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Solar-powered traffic signals: myth or marvel?

One of the negative effects of load shedding has been the congestion caused at intersections with traffic signal control. One of the many debates following the actions by Eskom is how traffic signals can be provided with power to allow them to continue running during times of load shedding. Solar-powered traffic signals have been proposed as one of the solutions and some municipalities have already proceeded with installing pilot sites. Solar-powered traffic signals are visible, make a statement and people tend to accept that they are beneficial without further analysis. The aim of this article is to place the power consumption by traffic signals in perspective, as well as to evaluate the different alternatives available for keeping traffic signals running during times of power failure or load shedding.

TRAFFIC SIGNALS AND POWER CONSUMPTION IN PERSPECTIVE

In order to calculate the power consumption of a traffic signal, a typical layout is defined. The layout of traffic signalised intersections is prescribed by the Southern African Road Traffic Signs Manual (Vol. 3: 1999).

There is a large variety in the layout and number of signal heads – whether an intersection is a T-junction or four-way intersection, whether it has right-turn phases or pedestrian signal heads can make a substantial difference in the total power consumption.

For purposes of comparison, a relatively simple intersection was used, namely a four-way approach intersection with three S1 aspects facing oncoming traffic from each direction. Figure 1 shows the typical layout.

During normal operation, three lights will be on per direction (as red, green and yellow cannot be displayed at the same time). Therefore, at any one time a total of twelve lights will be on.

At present, most traffic signals in South Africa still have halogen lamps, with a power consumption of 55 W. Light-emitting diode (LED) lamps use significantly less power, namely 15 W per lamp. The controller uses approximately 60 W, independent of the type of lamp used. Table 1 compares the total power consumption per intersection (power ratings and consumptions have all been researched from the public domain).

Since South Africa has approximately 14 000 traffic signals, the total power consumption is as follows:

- 14 000 traffic signals with halogen lamps: 10,08 MW
- 14 000 traffic signals with LED lamps: 3,36 MW

Potential saving: 6,72 MW

LED lamps are at present still relatively expensive; the costs are shown below:

- Standard S1 halogen head (red, yellow, green): R1 300
- Standard S1 LED head (red, yellow, green): R2 800

This implies that to replace 12 signal heads (one full intersection), will cost (material only) R33 600 per intersection. If labour is added, the total cost per intersection is estimated at R50 000.

To replace the halogen lamps of 14 000 traffic signals with LED lamps, in order to save the 6,72 MW, will cost R700 million. This is not an accurate figure as there are already many intersections in the country operating with LED lamps (although less than 500) and the actual number of signal heads per intersection will differ. The estimate of R700 million does, however, still provide an order of magnitude of the cost involved to convert to LED lamps.

To place the power consumption of traffic signals further into perspective, it should be compared with the total power consumption in South Africa. Various sources quote different...
numbers, but the capacity of Eskom at present is approximately 40 GW. An additional 4 GW is also needed to supply the immediate additional capacity required. Table 2 shows the power consumption of traffic signals compared with this.

The power consumption by traffic signals is therefore a relatively small percentage of the total Eskom demand – with halogen lamps accounting for approximately 0,025% and LED lamps for 0,008%.

**TRAFFIC SIGNALS WITHOUT POWER – THE REAL COST**

The real cost to the economy is not the cost of operating the traffic signals, but the cost in delays and additional fuel consumption when traffic signals are not working. Table 3 shows a basic calculation in which the additional cost was estimated if power outages cause ‘dead’ traffic signals, resulting in a one-minute delay per vehicle and assuming three more additional stops per vehicle. The finding is an additional cost of R15 000 per hour per intersection, or, if 1 000 traffic signals are not working for two hours – an estimated R30 million for the two-hour period. (This is regarded as a conservative estimate.)

**POWER CONSUMPTION BY TRAFFIC SIGNALS – THE ALTERNATIVES**

To reduce the power consumption by traffic signals, the following alternatives were evaluated:

- Correct form of intersection control (remove unwarranted traffic signals)
- Switching traffic signals off at night
- Changing halogen lamps to LED lamps
- Using solar-powered traffic signals
- Providing backup batteries which are charged when the power is on

The rest of this article will focus on the last two alternatives.

**PHOTOVOLTAIC (SOLAR) PANELS WITH BATTERY BACKUP**

As outlined below, a solar and battery system with adequate capacity to run a traffic signal with LED lamps will require a substantial number of batteries and solar panels. As shown above, halogen lamps will require three times more power than LED lamps (720 W vs 240 W) and are not regarded as a feasible solution with solar power and batteries.

A solar power supply system consists of four basic components, namely:

- batteries
- photovoltaic (solar) panels
- regulator
- inverter

The set-up is shown in Figure 2.

**Autonomy**

Autonomy refers to the time the traffic signal must operate on battery power without the solar panels recharging the batteries. The longest autonomy time will be required in winter when the nights
are long and the sunshine available to charge batteries is limited. A more critical scenario will, however, be in the rainy season when clouds can prevent charging of the batteries for two to three – or even more – days. This is more important in the regions of the country with winter rainfall.

The autonomy requirement is a critical design decision and to illustrate the impact of different autonomous times on the number of batteries and solar panels required, Table 5 was prepared.

**Batteries**

Assuming a total of 240 W is required for the traffic signal (see above) at 12 V, a current of 20 A must be available from the batteries. Typical deep-cell batteries used with solar-powered installations have current ratings of 102 Ah (ampere hours). The manufacturers recommend that the batteries should not operate at a depth of discharge (DOD) of more than 60% (www.windsun.com/Batteries/Battery_FAQ.htm#Lifespan%20of%20Batteries). To be conservative, this design was done using 50% of the Ah rating, i.e. 51 Ah per deep-cell battery.

**Solar panels**

The number of panels will determine how fast the batteries can be recharged while also powering the traffic signal. At present, typical photovoltaic (PV) panels do not deliver more than 7.5 A

![Typical layout of a simple traffic-controlled intersection](image1)

![Solar power supply system for traffic signal](image2)

### Table 4 Unit cost of different elements

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>102 Ah Deep-cell Battery</td>
<td>R 2 000,00</td>
</tr>
<tr>
<td>200 W PV Panel</td>
<td>R 10 000,00</td>
</tr>
<tr>
<td>Pole for PV Panels</td>
<td>R 20 000,00</td>
</tr>
<tr>
<td>Inverter</td>
<td>R 2 000,00</td>
</tr>
<tr>
<td>Regulator</td>
<td>R 500,00</td>
</tr>
</tbody>
</table>

### Table 5 Autonomy compared with number of batteries, panels and cost

<table>
<thead>
<tr>
<th>Design</th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autonomy (hours without sunlight) – assumption</td>
<td>12</td>
<td>24</td>
<td>48</td>
</tr>
<tr>
<td>Total Ampere hours required by traffic light</td>
<td>240</td>
<td>480</td>
<td>960</td>
</tr>
<tr>
<td>Number of batteries required (Ah/0.5/100)</td>
<td>5</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Hours sunlight per day – assumption</td>
<td>6</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Current required during charge time</td>
<td>120</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>Total ampere hours that must be replaced</td>
<td>360</td>
<td>640</td>
<td>1080</td>
</tr>
<tr>
<td>Current per panel (amps)</td>
<td>7.5</td>
<td>7.5</td>
<td>7.5</td>
</tr>
<tr>
<td>Total current provided in number of hours (Ah)</td>
<td>45</td>
<td>60</td>
<td>45</td>
</tr>
<tr>
<td>Number of panels (total Ah/current in charge time)</td>
<td>8</td>
<td>14</td>
<td>24</td>
</tr>
<tr>
<td>Area per panel (square metres)</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Total solar panel area (square metres)</td>
<td>9.6</td>
<td>16.8</td>
<td>28.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost Estimate (excluding installation, cabling and VAT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>102 Ah Deep-cell Batteries</td>
</tr>
<tr>
<td>200 W PV Panel</td>
</tr>
<tr>
<td>Pole for PV Panels</td>
</tr>
<tr>
<td>Inverter</td>
</tr>
<tr>
<td>Regulator</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>
at maximum power (during daily peak sun hours). Table 5 shows two scenarios, namely six and eight hours of sunlight.

**Regulator**
The regulator controls the current from the solar panel to the batteries. As the intensity of sunlight varies, the current supplied varies and the regulator manages the current to prevent damage to the batteries.

**Inverter**
The inverter is required to change the voltage from 12 V DC to 230 V AC as used by the traffic signal controller and the lamps.

### Costs of solar power
Table 4 shows the estimated unit costs related to the above design (costs researched from the public domain).

Table 5 shows a summary of various autonomy requirements and sun-hours available. It indicates for each option the number of batteries required, the number of solar panels and the associated cost.

### Solar panels – construction, theft and cost
The dimensions of a typical 200 W 7.5 A PV panel are approximately 1 500 mm by 800 mm and it weighs 15 kg (according to the datasheet of the Sharp ND-216U2 Photovoltaic Module). As shown in Table 5, the smallest installation will be 8.4 m$^2$ and the largest 29 m$^2$. A pole and a mounting structure that can withstand substantial wind loads will be required to support this, hence the cost estimate of R20 000.

Another aspect of solar panels that must be addressed is the risk of theft. Currently all solar installations in South Africa are experiencing a high frequency of theft.

An additional cost element therefore is theft-mitigation measures, such as anti-climbing structures, electric fencing around panels (using an energiser that can work with an inverter and the batteries), epoxying of panels to structures and even the latest technique available – satellite tracking of solar panels.

If, from Table 5, the typical solar-powered traffic signal costs, say, R200 000 to install, and we assume that a further R50 000 per signal is spent on theft-mitigation measures, the total cost for solar power supply is R250 000. If the specific traffic signal is in an area where electricity is readily available, it will be more cost-effective to provide normal Eskom supply. If we assume that the operational cost of the electricity is, say, R5 000 per annum, a simple calculation shows it will take 50 years to recover the capital cost. This excludes the fact that the batteries will require replacement every, say, three years and does not include the replacement cost of potential theft.
AIMS AND OBJECTIVES
The aims and objectives of the project were responses to multiple community needs. The first project objective was to ease the excessive morning and evening peak hour traffic congestion and the operational deficiencies of the entrance ramps to the Western Freeway. The peak hour congestion had reached fully saturated traffic conditions to the extent that the peak hour duration was exceeding two hours in the morning and evening.

The second objective was to respond to the need to rehabilitate the aging and severely cracked road pavement which was in a state of disintegration and delamination, causing unnecessary safety hazards and damage to vehicles. It was proposed to make the best use of the existing pavement structures to ensure a road surface of high standard that would be serviceable for at least 15 years, all to be undertaken with the least disruption to the peak traffic flow. This would ensure maximum utilisation of an existing asset.

A third project objective was enhancement of road user safety, general aesthetics, security and noise control, and meeting pedestrian needs along the Western Freeway corridor.

The fourth and final objective was to provide a public transport lane facility to encourage and assist the use of public transport.

The design approach was specifically aimed at meeting these four objectives. To address the capacity and operational deficiencies, the first step taken was a traffic analysis which indicated the benefits of increasing the number of lanes from three to four in each direction, plus adding a fifth auxiliary lane linking the entrance and exit ramps. This has proved not only to improve the road capacity during peak hours, but also to have significant operational

The Western Freeway is the ‘gateway’ for traffic entering the city of Durban from the N2 north and south, as well as the N3 from the west. The client, eThekwini Municipality Roads Provision, is well aware of the strategic importance of the Western Freeway, which is the busiest road in KwaZulu-Natal, carrying more than 120 000 vehicles daily. The Western Freeway was constructed in the early 1970s and had reached a stage when the road pavement was in dire need of heavy rehabilitation. Peak hour congestion had reached saturation levels and the service levels were very poor. Safety features and pedestrian facilities also required much attention.
benefits in that the previous 'bottlenecks' experienced at the ramp entrances have been eliminated through the introduction of the auxiliary lanes.

The design approach to address the deteriorating road pavement condition involved extensive pavement condition assessment and analysis, which included test pits, asphalt coring, bitumen-recovered analysis, rut measurements, Falling Weight Deflectometer measurements, riding quality measurement and a visual condition assessment. The pavement condition assessment, together with the community need for daily access into Durban, led to the approach of undertaking all asphalt rehabilitation work at night, opening the full roadway to three lanes during the peak traffic hours. The asphalt rehabilitation approach varied considerably, depending on the pavement condition. It varied from full-depth asphalt replacement, incorporating Glasgrid reinforcement matting in the asphalt, in the slow lanes, to light rehabilitation comprising the milling out and replacement of only the asphalt surfacing in the fast lane. The asphalt was also modified with Sasobit to enhance compaction at the lower temperatures encountered due to the night operations.

The design approach to address road user safety, aesthetics, security and pedestrian needs included the provision of a continuous concrete median barrier, of suitable height for the variation in design speed and sight distance, around the required road curvatures. Further safety enhancements were the provision of new and improved overhead signposting, the use of skid-resistant stone mastic asphalt surfacing, appropriate speed limits and, in particular, a concrete barrier on the outside curves of the freeway on the inbound carriageway adjacent to Randles Road where residents had in the past often experienced speeding vehicles crashing into their properties.
designed with additional height for sound deflection due to the close proximity of residential homes to the freeway.

With regard to security, the easy escape routes and hide-aways for criminals in close proximity to the freeway were addressed. The disused sub-ground level Berea Road South entrance ramp was closed up by constructing an 8-m-high integrated retaining wall, backfilling the old ramp and providing aesthetically pleasing landscaping.

Pedestrian needs have been catered for by means of a raised pedestrian walkway under Tollgate Bridge, as well as walkways linking the commercial nodes of Berea Centre, the KZN Technikon and the public transport terminals at Warwick Junction.

**PROJECT DESCRIPTION**

**Roadway features**

The roadway incorporates a Public Transport (PT) lane constructed using red asphalt. The red asphalt is a first for a PT lane application in South Africa and is unique in that a synthetic binder was used instead of a bituminous binder in order to achieve the maximum benefits of the red colour and maximum contrast with the remaining lanes.

The introduction of auxiliary lanes linking the entrance and exit ramps is unusual but, given the urban environment, high traffic volumes and the high number of entrance and exit ramps, these auxiliary lanes have significantly improved the operational efficiency of the Western Freeway. Long ramp queues, with entry traffic seeking entrance into already full and congested lanes, have been eliminated. All entry traffic now enters into a dedicated entrance lane which, some distance away, becomes a dedicated exit lane, but with ample length to allow safe and unforced weaving into and out of the adjacent through lanes.

Previously, traffic from Ridge Road seeking access to the Western Freeway was forced to make an unsafe right turn in Ridge Road and use a low-standard local street to gain access to Jan Smuts Highway and the Western Freeway. This problem has been resolved by means of a new link road between Ridge Road and Jan Smuts Highway. An unusual feature of the new link road is the recommissioning of a disused viaduct adjacent to the freeway, making effective use of an existing asset.

**Structural features**

- **Concrete median barrier**
  In order to achieve the maximum number of freeway lanes, a concrete median barrier was introduced to separate traffic moving in opposite directions. A single-slope barrier was selected on the basis of extensive research and for ease of construction. At the start of the project, when there was a higher entry and departing speed limit and where the roadway is relatively straight, a 1,1-m-high barrier was selected which had the benefit of eliminating headlight glare. Where the road curvature places limitations on the stopping sight distance on the inside of sharper curves, it was decided to lower the concrete barrier to a height of 0,8 m to allow sight lines over the top of the barrier. Around the sharpest curve on the project, the barrier was set back from the inside curve, again to achieve maximum stopping sight distance for traffic on the inside fast lane.

- **Barrier walls**
  On the outside edges of the freeway, concrete barrier walls were provided to ensure safety around the sharper curves and protection for the adjacent Garth Road and Randles Road. The community participation process, which was part of the environmental impact scoping exercise, highlighted the concern of residents living in Randles Road, which is adjacent to the freeway, that speeding vehicles often crashed through the guardrail, crossed over Randles Road and ended up inside their properties. The residents requested a higher-than-normal concrete barrier wall. The design therefore allowed for a 2-m concrete barrier wall between Randles Road and the freeway, which also acts as an effective sound barrier.

- **Brickfield Road bridge**
  The Brickfield Road bridge required widening to allow for the dedicated auxiliary lane from the Brickfield Road entry ramp. After extensive research of as-built records, it was established that the existing bridge deck has transverse posttensioned reinforcement and that it was not possible to simply break back and widen the existing bridge deck. In order to solve the problem, it was decided to construct an independent bridge deck adjacent to the existing one and to provide continuity between the bridge decks by means of a mechanical joint in the longitudinal direction. This has proved...
to be a more cost-effective solution than constructing a full, new bridge deck.

Waterfall bridge

The widening of Waterfall bridge posed challenges due to the nature of the existing road embankment fill material, which consists of non-cohesive sand with large boulders. This sand embankment created stability problems which necessitated extensive temporary shoring, Guniting and piling through the embankment material to competent foundation material, rather than spread footings as used in the original bridge. This process ensured that the roadway remained trafficable during the bridge widening operations.

PROBLEMS ENCOUNTERED AND INNOVATIONS

Traffic accommodation

A major planning and programming constraint of the project was the effective accommodation of traffic throughout the construction period in view of the requirements to construct a concrete barrier in the roadway median over the full length of the project, the widening of the roadway on both the left and right-hand sides and the necessary road pavement rehabilitation.

A requirement of the project was that the original full three lanes must be available during both the morning and afternoon peak hours. This was achieved in practice by programming the widening and structural works for day construction, with limited access during the peak hours, and rehabilitating the existing pavement layers as a night-time operation.

This approach proved successful and minimised disruption to the peak hour traffic. It was particularly gratifying to be able to report that these arrangements did not cause day-time accidents that could be attributed to the construction activities and that the night-time operations were accident-free.

Pavement rehabilitation

The existing road pavement assessment and strength analysis clearly showed variable pavement performance and condition characteristics. This variable pavement condition resulted in a variable rehabilitation design which included:

- replacing asphalt to variable depths, depending on location and heavy loading expectancy
- strengthening the new asphalt by means of fibreglass reinforcement (Glasgrid)
between the new asphalt layers at selected locations

- use of a bitumen modifier (Sasobit) in the asphalt manufacturing process to allow compaction at lower asphalt temperatures than normal due to the colder ambient temperatures experienced during night operations
- strengthening of the slow lane subbase layers where there was inadequate support; this was achieved by means of in situ stabilisation using appropriate deep milling, mixing and compaction construction plant

The final asphalt surfacing layer was not conventional asphalt, but was designed as a Stone Mastic Asphalt (SMA) which has excellent rut resistance, skid resistance, overall performance and noise-absorption properties. In the urban environment of this project, with exceptionally high peak hour traffic volumes, SMA minimises road traffic noise and maximises skid resistance, which is required due to a high percentage of rear-end-type accidents. The high performance SMA was achieved by means of stringent control of stone aggregate grading and flakiness, and specification of the type of stone and the bitumen content, followed by mix design alternatives during the construction stage.

Red asphalt for the Public Transport lane

A number of options were investigated to achieve a colour contrast between the normal lanes and the new Public Transport (PT) lane. The best results were achieved using a synthetic binder imported from France and a locally produced red oxide colourant. The SMA surfacing mix, slightly modified, was used as the base mix for the red asphalt.

Law enforcement on the use of the PT lane is by means of camera recording of vehicle number plates. Non-PT vehicle numbers are recognised and followed up by prosecution procedures.

The PT lane is the first fully dedicated public transport lane for Durban and has pioneered the implementation of similarly dedicated PT lanes at other locations in Durban.

**Project communication**

Communicating with and informing the public regarding the work in progress was done by means of a web portal, updated on an ongoing basis to keep the public informed about traffic restrictions, temporary closures and work areas, as well as giving them an overview of the project programme and objectives. In addition to the web portal, other media releases included information articles in the local press and radio station traffic reports. The introduction of the PT lane received extensive exposure in the local press, particularly since it was a ‘new’ concept for many local road users. This resulted in a smooth opening with very few violations.

Another communication endeavour was personal house-to-house visits to those residents living adjacent to the freeway, advising them of the timing of blasting work and temporary vibration disturbance during asphalt construction.

These pre-emptive information visits resulted in very few complaints from residents living adjacent to the freeway.

**Optimum use of recycled asphalt**

In order to achieve the objectives of an environmentally friendly project, the planning and design made optimal use of milled-out old asphalt on the project. To this end both the selected pavement layers of the widened roadway and the reinforced earth embankment approaches of the New Link Road were constructed using recycled asphalt. The balance of the milled-out asphalt was hauled to an eThekwini Municipality maintenance depot for other similar uses.

**PROJECT STATUS**

The major work components, including the roadway widenings, pavement rehabilitation, structural works and the Public Transport lane, were completed in May 2008. Minor additional works requested by the Client were due for completion in August 2008.

**CONCLUSION**

The project has provided the eThekwini Municipality with an asset that has been highly responsive to the community’s needs, has involved contractors at development level, has included a high degree of municipal engineer involvement in the fiscal and phasing requirements, has included innovative asphalt designs and is a ‘first’ with regard to providing a dedicated public transport lane in KwaZulu-Natal and Durban, with minimal environmental impact and significant aesthetic and safety improvements.

**PROJECT TEAM**

**Client:**
eThekwini Municipality Roads Provision
Roy Gooden, 031 311 7601

**Professional team**

**Consultants:**
Vela VKE Consulting Engineers/
Eyethu Engineers Joint Venture
Dawie Erasmus 031 240 7300

**Contractor:**
Group Five/National Asphalt/
Milling Techniks Joint Venture Consortium
Errol Tate, 031 569 0300

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**Figure 1:** Single slope median barrier wall under construction
**Figure 2:** Temporary shoring at Waterfall bridge widening
**Figure 3:** ‘glasgrid’ reinforcement of the asphalt layers
**Figure 4:** Completed widening, Public Transport lane and median barrier
Will better public transport services increase ridership?

Case study of the Jammie Shuttle at the University of Cape Town

THE UNIVERSITY OF Cape Town’s (UCT) student and staff transport service was previously introduced to SAICE readers in the November/December 2005 issue of Civil Engineering (Vol 13 No 11). In that article Brenda Sudano of Ninham Shand highlighted the various goals of the newly branded UCT transport service, known as the Jammie Shuttle (JS). Ninham Shand, represented by Dr Wayne Duff-Riddell, is still involved and offers continued support and advice regarding the ongoing improvements to the JS.

The Jammie Shuttle, which can be seen as the first recapitalised public transport service in the country, has been operating for the last two-and-a-half years. According to Property and Services (PPS) at UCT, the ridership has increased from 16 000 (in 2005) to 42 000 person trips per day (interview with J Critien from PPS, 1 August 2008). This increase in ridership clearly indicates that the JS service has been, and will continue to be, a success. However, PPS was under the impression that the service is used mainly by students. It was estimated that less than 1% of UCT staff members use the shuttle. Accordingly, a study was commissioned in 2007 to investigate the reasons why staff members were not utilising the shuttle and to determine what measures could be implemented to change this state of affairs.

A questionnaire was developed and all members of staff were targeted. The survey aimed to gather general information from staff, obtain perceptions of travel to UCT and determine the significance that people attach to various travel attributes. Sections 2 and 3 of the questionnaire were designed specifically for staff who travel to UCT by private vehicle. In an attempt to understand people’s preferences, and how they use those preferences to make choices, a survey technique called Stated Preference (SP) was included.

A total of 1 033 respondents were involved in the survey. The dominant mode of transport used to travel between a place of residence and UCT was the private motor vehicle, totalling 75% of all respondents. A multiple regression analysis was performed on subgroups within the SP data to find out whether there were particular factors that influenced a respondent’s choice. Three variables were considered in the analysis – travel time, type of Park and
Ride (P&R) facility and cost. By changing the levels of these variables, a respondent's sensitivity to each of the factors could be determined. Various hypotheses were proposed and the data were used to confirm if these were indeed valid.

One of the interesting findings of the study was that almost a fifth of respondents currently utilise the JS service. This was far greater than the 1% previously estimated. Additional calculations indicated that trips by these 18% of staff members make up 4% of the total number of trips. There is a likelihood that students make multiple trips during the day, while staff generally arrive on campus in the morning and leave in the afternoon (two trips/person/day). Hence the contribution of staff trips to the overall number of trips on the JS is low, which might account for the perception that very few staff utilise the service.

The results of the survey yielded the following additional conclusions about staff travel at UCT:

1. Factors that could explain why staff members are not willing to use the Jammie Shuttle
2. Distribution of obligations according to gender
3. Jammie Shuttle – University of Cape Town (photographs: Angus Rule)
Single occupancy vehicle use is overwhelming at UCT with 36% of respondents stating that they travel to UCT by car and travel to the Upper Campus with only one person in the vehicle.

The majority of staff reside in close proximity to UCT. Average travel times to work range between 21 and 30 minutes, and approximately two thirds (64%) of respondents reside within 15 km of their workplace.

Obligations influence a staff member’s willingness to make use of the JS. Almost two thirds (64%) of respondents stated that they had obligations that they could only fulfil if they used their own vehicles. Three obligations were commonly referred to by staff, namely children, work-related or private.

Convenience is a major concern when staff members consider utilising the JS. Vincent (2007) suggests that the success of P&R schemes relies on their being market-oriented. Potential P&R users will usually have the option to make their complete trip by car. Therefore, in order for a system to be successful, it must offer a level of service comparable with that of making the full trip by car. This is supported by the overwhelming majority (93%) of respondents in this survey who stated that convenience is the reason they do not use the JS.

Increased fuel and parking prices cause staff to consider alternative transport. Almost 50% of respondents would be encouraged to consider the JS if the price of fuel increased to R10 per litre. The constant growth in the number of trips with the JS indicates that a move towards public transport is taking place.

Almost 90% of respondents revealed that they would be willing to use P&R facilities. This could provide the required incentive for UCT to continue with plans to introduce new P&R facilities. These conclusions have illustrated some of the trends in staff travel behaviour and highlight the dependence on private vehicles. Despite this dependence, there are external factors that are beginning to impact on commuter travel. These factors have started to compel private vehicle users to consider alternative transport options. If a public transport system can be continually improved, ridership on these vehicles will also continue to grow.

The definition of ‘better’ public transport will be different for every individual. However, general concerns about convenience, security and reliability are fundamental issues and they need to be addressed in order to provide a ‘better’ public transport service that will encourage private vehicle users to switch to public transport.

REFERENCES


If a public transport system can be continually improved, ridership on these vehicles will also continue to grow.
Rolling out roads in Randfontein

The ENERGYS programme (Engineers Now Ensuring Roll-out by Growing Young Skills), initiated and managed by SAICE’s Allyson Lawless under the auspices of the SAICE Section 21 Company, and now funded by the Development Bank of Southern Africa’s Siyenza Manje programme, aims to accelerate and facilitate the transfer of skills to young graduates and students busy with their experiential learning, under the guidance of retired engineers. In the process graduates and students gain a wealth of knowledge through exposure to latest and existing technology. An invaluable ‘by-product’ of this capacity building programme is the unblocking of bottlenecks in local government service delivery. The rehabilitation of various roads in Randfontein serves as visible proof of the success achieved through this programme.

Regravelling of roads in the Randfontein rural area

The rehabilitation of gravel roads in the Randfontein rural area, where exposed rock on stretches of the road were damaging vehicles, entailed treating the gravel with several agents to investigate the optimum mix of materials. Dramatic blading and covering of the exposed rock by imported material offered substantial relief to the local municipality, thereby enabling the municipality to focus on other areas that needed maintenance as well.

The students who were involved in this project participated in site meetings, wrote minutes and learnt about the tender process. They also engaged in borrow pit sampling and material

1. Rehabilitation of a gravel road in rural Randfontein by chemical modification to reduce maintenance
2. The completed gravel road
3. Not such a rarity any longer – lady students on site
4. Site meeting out in the open
testing, and learnt to use the Dynamic Cone Penetrometer.

This rehabilitation project was completed in February 2006 and the results are still evident in that these roads now only need routine maintenance.

**R28 – R559 intersection**
The concrete block surface of the busy intersection along the R28 through Randfontein and the R559 towards the rapidly growing industrial area had been damaged beyond repair and the Concrete Manufacturers Association (CMA) offered new blocks that would be resistant to the heavy loads and regular spillage from trucks transporting concrete material through the intersection. This project was also completed in February 2006.

The student assigned to this project assisted with the survey of the intersection and mapping this for calculation of quantities, as well as searching for the existing drainage. This map was very useful in obtaining wayleave from Gautrans and indicating the accommodation of traffic on the busy intersection. While searching for existing drainage, the student and the contractor discovered a decades old drainage system, which was then extended to alleviate the continual ponding of water.

**Design-build mode of delivery**
During 2007 and 2008 pavement rehabilitation of primary and secondary roads in the Randfontein area took place for the first time in many years. This contributed immensely to preserving well built pavements. However, a number of pavements that had been damaged beyond repair had to be rebuilt.

The lack of capacity in the Directorate Infrastructure was overcome successfully by using the design-build mode of delivery. As information had to be compiled in record time for the tendering process, the students on this project all became involved in assisting the local maintenance team with the sampling and testing of pavement materials. Each person played an important part in this process of delivering on time and the level of excitement among all those involved was quite tangible. At the same time a number of students who had been mentored in traffic counting, neatly recorded time slots and different classes of traffic from 7 am until 6 pm over a number of cold winter days.

The consultants used the latest technology for rehabilitation, such as rut resistant asphalt and deep in situ recycling. During this operation officials from the local authority were not only exposed to the latest technology, but also attended a workshop at Gautrans for the first time where they met with road specialists, as well as with their counterparts in the Metros.

One of the students, Joseph Rakobo who had graduated in the meantime, continued on the project, writing minutes, studying the SAICE Practice Manuals, and familiarizing himself with other duties, such as the issuing of handover/completion certificates, checking payment certificates and applying specification in some instances.

**Conclusion**
The ENERGYS approach is one of the win-win solutions offered by SAICE to alleviate the skills crisis in South Africa. One after the other these ‘smaller projects’ are contributing significantly to making the world we live in a better place.
R28 – R559 intersection

1. Very busy R28 – R559 intersection, Randfontein
2. Replacing failed concrete blocks at the R28 – R559 intersection with latest technology concrete blocks donated by the CMA, whilst accommodating heavy traffic
3. Remnants of a drainage system that is at least 50 years old. Note the neat drywall construction and the corrugated iron that acted as roof to the concrete channel. The existing draining channels were cleaned out by water injection, checked for stability and re-used in the layout of the rehabilitated intersection.

Design-build mode of delivery

4. Lazaar Avenue, Randfontein, before rehabilitation. Note unstable asphalt
5. Lazaar Avenue, Randfontein, after modification and compaction
6. Sampling of in situ pavement material for testing (student Joseph Rakobo at left has since completed his studies)
7. During the rehabilitation of Tambotie Street, Randfontein, students were exposed to in situ recycling and also learnt about chemical modification for strengthening
8. During the rehabilitation of Randfontein’s well-known Mill intersection students were introduced to advanced technology when unstable asphalt was replaced by rut resistant asphalt mix

[Images of construction sites and rehabilitation processes]
THE SAICE TRANSPORTATION Division held its annual awards luncheon on 18 April 2008 at the Blue Valley Golf Estate in Midrand. Apart from providing valuable networking opportunities, this event also offered occasion to recognise and reward achievements in the transportation engineering fraternity.

The Chairman’s Award went to Dr John Sampson for his outstanding service to the transportation engineering profession over the last 36 years. John is currently Chairperson of the Board of Directors of the Road Traffic Management Corporation, Provincial Roads Expert for Gauteng Transport Management Authority, Managing Director of Transportation and Traffic Technology Africa, and a Director of Jeffares and Green. Other positions that John held in his career include Deputy City Engineer of Johannesburg, Professor at the University of Pretoria, General Manager (Housing) of FHA Homes, President of the South African Road Federation, and Chairman of the SAICE Transportation Division. He has also contributed to and co-authored publications such as the SADC Road Traffic Signs Manual, National Guidelines for Road Access Management in South Africa, Route Marking in South Africa, the Gauteng Roundabouts Design Manual, the Gauteng Transport Study GTS 2000, Municipal Engineering Services Contributions Policy, and a Policy for Traffic Impact Assessments. His PhD thesis on Warrants for Traffic Signals is now an industry standard. (See opposite page for an edited version of Dr Sampson’s acceptance speech. Ed.)

Three other awards were also made. Dr Bridget Ssamula from the University of Pretoria and Eben de Vos of the University of Stellenbosch received book prizes for the best post-graduate students in transportation engineering in the Department of Transport’s Northern and Southern Transportation Centres of Development respectively.

The best paper award went to authors P J Strauss, B D Perrie, L du Plessis and D Rossmann for their paper titled Accelerated pavement testing of load transfer through aggregate interlock and the influence of crack width and aggregate type – a case study.
SAICE Transportation Division Chairman’s Award 2007
for outstanding service to the transportation engineering profession

Acceptance speech by Dr John Sampson

TRAFFIC AND TRANSPORTATION engineering is the newest branch of civil engineering and it has taken some time to be truly accepted as a legitimate contributor to the civil engineering profession. The first traffic engineer in South Africa was Sawille Dorfman, the Chief Traffic Officer of Johannesburg, who studied at Ohio State University, USA, in the 1960s.

At that time, responsibility for intersection design and all traffic control, including road signs and markings, rested with the traffic department (in many towns and cities in South Africa it still does) and the design engineers had to get a stamp of approval from the traffic department before they could implement their scheme.

The first Road Traffic Signs Manual (RSTM) was prepared by the Cape Provincial Roads Department on behalf of the five provinces and was produced in 1970. The manual was about 2 cm thick – a little smaller than the four-volume, 14-file-thick SADC RTSM which will line a full shelf in most of your bookcases today!

Later versions were produced by the CSRA/CUTA sub-committee. CSRA was the Committee of State Road Authorities and CUTA the Committee of Urban Transport Authorities. SAICE was also invited to become a full-time member of the Committee.

Today responsibility for producing national guidelines rests with COTO, or the Committee of Transport Officials, which was formerly COLTO, the Committee of Land Transport Officials. COTO is a sub-committee of MINCOM, the Ministers’ Committee, which retains ultimate accountability.

The major changes in the RTSM over the years have been:

- the change in the colour of signs to ensure international conformity
- the removal of virtually all wording on signs to overcome the multiple language problem
- the introduction of signs to deal with multi-lane situations

Other documents that are the responsibility of COTO are Highway Design Manuals, Route Marking and Numbering, and the National Guidelines for Road Access Management in South Africa (RAM).

It is a big disappointment to me that the draft RAM document has not yet been approved by COTO, apparently for the simple reason that COTO has not reached this item on its agenda. Why it is important is that RAM provides the only comprehensive solution to the two most critical issues in road management today, namely congestion and safety.

How does it do this? By forcing the planners and design engineers to choose what the road’s true function is. The primary function of a road can be only one of two things – to provide mobility or to
On activity roads, provision is made for access and all the activities associated with access, such as pedestrian movements, public transport stops, loading, parking and turning into driveways. Hence activity streets must provide for slow-moving, short-distance traffic, traffic calming, sidewalks with regular pedestrian crossings and even for children playing in the street.

Provide for activities, including access. Mobility roads provide for large volumes of traffic moving at relatively high speeds over longish distances. On the public transport side, these are represented by BRT routes.

On mobility roads, access is restricted to intersections at spacings of 600 m or longer, and physical separation of turning and pedestrian movements is required. Mobility roads provide the backbone of a city’s and country’s economic growth, and the effect of not managing these roads is literally a strangling of entire regions or CBDs.

On activity roads, provision is made for access and all the activities associated with access, such as pedestrian movements, public transport stops, loading, parking and turning into driveways. Hence activity streets must provide for slow-moving, short-distance traffic, traffic calming, sidewalks with regular pedestrian crossings and even for children playing in the street.

The two functions can never be mixed. At a recent Make Roads Safe Conference in Uganda, the representative from iRAP (International Road Assessment Programme) said there are only two truly safe roads. The first is when vehicles are restricted to moving at 30 km/h or less (local activity street), and the second is where all the vehicles move in the same direction at the same speed and are physically separated from conflicting vehicle and pedestrian movements (freeway). The problem lies with roads that operate between these two.

This is the principle of RAM. You cannot mix mobility and access. If you try, which most cities in South Africa still do, you destroy both. You disrupt mobility, create congestion and provide a highly unsafe environment for both vehicles and pedestrians.

Two other major initiatives taking place at the moment are the Policy for Engineering Services Contributions and the Policy for Traffic Impact Assessments. The first provides probably the only sustainable source of funding for new road construction and the second the criteria for allowing developments to proceed in an orderly manner.

Now let me move on to the Road Traffic Management Corporation (RTMC). The prime function of the RTMC is to improve traffic safety in the country. To do this, the RTMC has been given the coordination and facilitation roles to ensure the following:
- Law enforcement, including training and supporting provincial and municipal traffic officer functions
- Driver licensing and training (learner, driver and renewal of licences)
- Vehicle licensing (testing, overload control, standards, annual renewal)
- Public education and communications (children and adults)
- Traffic information (NaTIS)
- Administrative Adjudication of Road Traffic Offences (AARTO) – the points demerit system
- Crash investigations
- Road safety audits (SARSM)

As you can see, I have been dealing with an eclectic mix of planning and traffic engineering developments, but I will now turn to what to some is a confusing mix of voluntary organisations.

The South African Institution of Civil Engineering (SAICE) is a learned society set up to further the interests of civil engineering as a profession. SAICE is involved in schools and universities education standards, dealing with shortages of trained engineers and continuing professional development, in other words doing everything possible to promote and foster individual civil engineers and technicians, regardless of their employers.

The Engineering Council of South Africa (ECSA) provides professional registration in terms of the Act.

SAICE’s Transportation Engineering Division and the Institute of Transport Engineers (ITE) represent the interests of civil engineers with a specific interest or employment in transport-related issues.

The South African Academy of Engineering (SAAE) provides a platform for the top thinkers and influential people in all branches of the engineering profession and advises government.

The South African Association of Consulting Engineers (SAACE) deals with the business interests of member firms, including fees, tenders, contracts, financial management and client liaison for all branches of engineering. (SAACE has subsequently changed its name to CESA, i.e. Consulting Engineers South Africa. Ed.)

The South African Federation of Civil Engineering Contractors (SAFCEC) is the sister organisation to SAACE (now CESA).

The South African Road Federation (SARF) promotes safe, properly maintained and appropriate roads on behalf of the broader roads industry. Members include fuel suppliers, tyre and vehicle manufacturers, contractors, consultants, government agencies, researchers, traffic officers, etc. It is the mouthpiece of the roads industry.

The Road Freight Association (RFA) and the South African Bus Operators’ Association (SABOA) represent specifically the interests of truckers and freight hauliers/bus operators.

The Chartered Institute of Logistics and Transport South Africa (CILTSA) deals with the logistics and economics of transport, often concentrating on the movement of goods and freight handling, but also the movement of people.

The South African Society of Intelligent Transport Systems (SASITS) is concerned with all intelligent transport systems, which could be traffic signals, in-vehicle information, traffic monitoring, smart cards, electronic toll collection, etc.

The Automobile Association (AA) takes care of the cost, safety and convenience of individual motorists, offering maps and tourist support, as well as vehicle rescue and insurance.

In conclusion, the transportation and traffic engineering profession has come a long way in the 40 years of its existence and has had a major influence on the economic and social development of this country. I am privileged to have been a part of it and am sincerely grateful to SAICE for recognising my small role. I thank you for this Award.
The earliest South African road bridges outside of a town

ROAD BRIDGES ARE things which are useful when one has to take a road over a river, or a railway line, or another road, or where circumstances make it more economical than building a fill. Although I did spend time in the Cape Provincial Roads bridge design office, this aspect of civil engineering never excited me.

I have, however, got rather wrapped up in the historical side of road building in our country, especially in the Cape, and inevitably various river bridges became important milestones (as it were) along the way. For just as our mountain ranges presented barriers which required the padmakers (road makers) to locate, design and construct mountain passes to open up the country ‘on the other side’, so rivers presented obstacles which had to be overcome, for similar reasons.

To cross a river the original pathfinder first looked for a place suitable for use as a ford or drift. Sometimes he was lucky and found a levellish shelf of rock, long enough to spread the waters shallowly, and with reasonable approaches on either bank. But most times he was not so lucky, and had to make do with a softer river bed, and approaches which would delight the present-day off-road adventurer with his 4 x 4 and winch!

The softer river bed could be accepted provided it did not get too soft. Should this happen, our forefathers would first of all look for another crossing point, for it is well documented that the early travellers and transport riders were not at all keen on actually doing something themselves to improve a road. Thus we find many instances where the original wheel tracks got rather deep or rocky, and rather than repair them the travellers opened a new track along-side the original one. This is, for example, well illustrated in Johannes Schumacher’s painting ‘Hottentots Holland Kloof in 1776’ (reproduced in The romance of Cape mountain passes, p 15), wherein a multiplicity of parallel tracks is clearly depicted.

However, sometimes no suitable crossing point could be found in that vicinity, and then the thwarted traveller would be forced to attempt to harden the bed of the drift with branches or logs or stones – or with a combination of these. At a later stage, when road builders were appointed, crossings were sometimes raised slightly and on occasion provided with culverts to carry low flows below the roadway (we do this to this day!), and their beds were hardened by the systematic and planned provision of a stone roadway. Thus we find Thomas Bain building what he reported as being ‘a stone waterway’, consisting of stones large and heavy enough to avoid being washed away, across the Knysna River, near Eastford, in 1862 (present day photograph in Pat Storrar’s A colossus of roads, p 47). This worked well but, as might have been expected, there was a minority of ungrateful travellers who complained about the bumpiness of the crossing – one cannot please everyone all the time!

All this did not help during periods when a river was in flood, with the result that travellers were forced to wait, sometimes for weeks, for the river to subside before they could cross.

Which is where the bridges came in.

Oudebrug

The first bridge outside a town is said to be that over the Palmiet River on the Groenlands plateau between present day Sir Lowry’s Pass and Houw Hoek Pass, past Grabouw. Here, although the river could be crossed quite happily during most of the year, travellers could be delayed at the drift, in the rainy season, until the water level fell sufficiently for them to cross. That intrepid explorer, Sir John Barrow (1801), who was there in 1798, wrote “for eight months of the year it scarcely contains a drop of water, but
is mostly impassable the other four.”

Opinions differed as to what was a fordable depth of water. Impatient travellers who did not wait long enough for the river to subside far enough were in danger of coming to grief, as happened in 1799 to Assistant Surgeon Patrick of the 8th Light Dragoons, who felt that the river had gone down far enough for him to cross on his horse, but was most unfortunately swept away. Both he and his horse were drowned (Barrow, 1801).

By 1801 Semple (1968:127) crossed over the flooded river in “a flat-bottomed boat, with two upright beams, through which a rope was reeved, which passed across the river, and was made fast on each side. We put our saddles into the boat and, taking our seats, were pulled across by means of the rope, each one holding the horse by his reins.” He further comments, “This being our first swimming adventure, we were greatly pleased when we found ourselves safe on the other side.” Indeed.

After much wrangling, it was decided to build a bridge. This was a big decision, not only for the local crossing, but also because this would be the first bridge outside a town.

What sort of bridge was this? Dr Edmund Burrows, in his Overberg odyssey says (1994: 28) that no picture is known to exist of the bridge. If you go to the Cape Archives they will, in their usual helpful way, dig out a picture marked as being of this bridge, showing a wooden bridge on wooden piers. But Lieutenant James Ewart (1970:56, 61), on furlough in the Cape, writes that “in the latter end of 1811... we crossed the Palmiet river by a newly erected wooden bridge supported on stone buttresses.” Then, also, the Rev Bishop Christian Ignatius Latrobe (1969:292), who passed that way on 4 June 1816, left a fairly comprehensive description: “We passed over the bridge, which is of wood and the only bridge in the whole South Africa. It rests upon stone piers... To prevent the woodwork from being washed off the piers in great floods, the timbers are fastened to them by strong chains, on the side of the water’s descent. The bridge is furnished with railings, and on the floor-planks, the thick spungy stalks of the palmite-plant are laid in abundance, partly to afford an easy passage for the bullocks’ feet, and partly to deaden the sound of the wood by which they are apt to be frightened.” So it looks pretty definite that the piers were of stone, and as if Ted Burrows was correct in saying that there is no known existing picture of this bridge, which came to be called the Oudebrug when a new bridge was constructed. (I shall be very pleased if someone proves me wrong by producing a picture of this, the first bridge outside a town!)

Incidentally, Latrobe’s statement that this was “the only bridge in the whole South Africa” is a slight exaggeration if one includes bridges within towns. Just as one example, the urban Westerford Bridge in Newlands, a stone bridge, was built by Thibault circa 1800.

This Oudebrug was built in 1811. As a matter of interest, a second wooden bridge, 110 m long on wooden piles, was built over this river in 1852 by the Central Road Board, about two kilometres upstream of the Oudebrug, probably the one pictured in the Archives (Burman, 1970:91; 1973:16). This is where the outspan was situated, and is where the town of Grabouw now stands.
1928 saw the first concrete road bridge on the Grabouw main road (Johnston & Stuart-Findlay, 2005:112), and in 1958 a massive concrete bridge of six 50 ft spans was built to carry the then new national road high over the Palmiet River (PRE’s 1958/59 Report).

The Oudebrug disappeared long ago.

Beinbrecht Bridge
A bridge which has not disappeared is the Beinbrecht Bridge over the Riviersonderend at the Bavianskloof Mission Station, renamed Genadendal in 1806 (north of Caledon). This was built under the direction of local missionary John Beinbrecht, between 1818 and 1820.

The bridge originally consisted of five quite substantial stone piers, about 3.5 x 1.5 m, and six metres apart, plus approach spans on either bank, with a wooden superstructure. It was a colossal project to be undertaken by a private citizen at that time, and accordingly “was spoken of with astonishment from Cape Town to Grahamstown” (Burrows, 1994:75,76) – which means just about everywhere in the Colony (painting of original bridge: p 80 in Burman’s Waters of the Western Cape).

Originally the bridge was intended for the use of pedestrians and equestrians only, and was undoubtedly greatly appreciated by pedestrians particularly as, when Bishop Latrobe forded the river during the dry season in January 1816, he recorded that the water reached to the middle bodies of his oxen. The river can be easily, if damply, forded most of the year, but during mid-winter the run-off can make crossing impossible. It is therefore not astonishing to find that the ‘pedestrian bridge’ was also used by ox wagons on occasion – presumably when John was not looking.

Two years after completion a flood carried away the deck, but the piers were undamaged. So they raised the existing piers by two metres, added an extra pier on either side, and provided a more substantial deck. In 1881 the new pier on the left bank was washed away, and was only replaced in 1912, six years after the Divisional Council had taken over responsibility for the bridge. At the same time the wooden deck, which had been damaged and repaired intermittently over the intervening years, was replaced by a steel deck (J J Oberholster, 1972:105).

Although it was replaced as the official crossing over the Zonderend River by an adjacent two lane reinforced concrete structure with eight 13.35 m spans in 1989, the Beinbrecht Bridge, opened in 1821, lengthened, strengthened and now provided with a concrete deck, still exists and can be crossed today should you so desire (PGWC Structure B5506 Inventory Detail Report; Pers com: Dr Isaac Balie, Genadendal Museum, 2006-11-22).

Jan Joubertsgat Bridge
A third rural road bridge which deserves mention is the Jan Joubertsgat Bridge, on the Franschoek pass. This section of the Franschhoek pass has an intriguing, and sometimes incorrectly reported, history.

Originally it was one of the many passes named Die Olifants Pad, and travellers battled up the steep tracks which animals, especially elephant, had made in their annual migrations. Obviously no bridge yet.

The first constructed road was by a local farmer, S J Cats, who in 1819 built a sort of pass road, along a line chosen by the local surveyor W F Hertzog. Mr Cats is maligned as having built the pass so steeply that it could not be traversed by a fully laden wagon, which I have always thought to be grossly unfair seeing that the line had been chosen by Mr Hertzog! Be that as it may, when he came to the Jan Joubertsgat ravine he took his road steeply down from the pass summit to the floor of the valley to avoid having to bridge the ravine. Still no bridge.

Next came Major William Cuthbert Holloway of the Royal Engineers, who built the first engineered pass in the country, on a new line. In 1824 he avoided the steep descent at Jan Joubertsgat by building a bridge over the ravine, with a single span deck of local timber on stone abutments. He was thus able to follow a more gradual descent, much to the approval of the local transporters. At last a single span wooden bridge.

Ten years or so later Holloway’s softwood bridge deck was rotting, and Major Charles Cornwallis Michell, Surveyor-General, Superintendent of Works and Civil Engineer to the Colony decided that, rather than having regularly to replace a rotting wooden deck, the bridge should be converted into a stone arch structure by chopping the tops off the existing stone abutments and using them as springing points for his arch. This was duly done in 1834, giving us a stone arch bridge with a single span of 5.56 m. Michell’s was the first rural stone arch bridge in the country (photographs of the bridge: Burman, 1963a:34; Van Renssen, 1996).

Now things got a bit confused. The replacement of the Jan Joubertsgat Bridge was one of many minor items which Michell directed, and it got little prominence, with the result that most writers credited the arch bridge to Holloway.

In fact, the official proclamation of the stone arch bridge as a historical monument gives the construction date as 1823, and claims that the bridge is the oldest remaining bridge in the country (J J Oberholster, 1972:84). I also credited Holloway with its construction in The romance of Cape mountain passes! The true status of the bridge came to light in 2006 when Gordon Richings published the results of his many years of research in The life and work of Charles Michell (p 140).

In 1933 Holloway’s pass was upgraded, and the Jan Joubertsgat Bridge was widened to cater for the improved geometric standards of that time. Michell’s stone arch bridge still continues to carry all the traffic passing that way.

Keur River Bridge
The stone arch bridge over the Keur River in Montagu Pass, behind George, also designed by Michell, was opened on 8 January 1848. Although a proclaimed national monument, this rather attractive 9 m span bridge has received very little attention by writers, possibly because it was generally included as a minor bit of the famed Montagu Pass construction, which has of course been written up in considerable detail. The Keur River Bridge is (probably!) the oldest unaltered stone arch bridge, outside of a town, which is still in use.

So what have we got?
It appears that:
- The earliest rural road bridge was the Palmiet River Oudebrug, built in 1811
- The oldest rural road bridge still in existence is the Beinbrecht Bridge, built 1818 to 1820
- The oldest rural road bridge still in regular, daily use, and the earliest stone arch bridge, is the Jan Joubertsgat Bridge, built in 1834
- The oldest unaltered rural road bridge, still in regular use, is the Keur River stone arch bridge in Montagu Pass

At least, I think that’s right!

REFERENCES
Please contact the editor for the list of references
PROVISION OF BACKUP BATTERIES
(CHARGED WHEN THE POWER IS ON)
To keep traffic signals operational when there is load shedding or a general power failure, a battery backup or Uninterrupted Power Supply (UPS) can be provided at each traffic signal. The batteries are charged with the normal electricity supply when it is on, and the batteries are used only when the supply is down.

The components of a battery backup system are:
- batteries
- regulator
- inverter

Batteries
To provide a six-hour backup at 20 A/h, the batteries must be able to deliver 120 A. This can be achieved using three batteries.

Regulator
A regulator must be chosen according to maximum recharge current required.

Inverter
An inverter similar to that used for the solar power alternative must be used.

Battery backup costs
Table 6 summarises the estimated cost of the backup battery described above.

The price excludes cabling costs and VAT. If we assume that the enclosure for the batteries to protect them against theft will cost a further R10 000 per intersection, this brings the total cost to about R20 000.

CONCLUSION
A politician made the statement, “Traffic signals are real power guzzlers”, but this article has shown that this statement is incorrect.

We have also shown that if a benefit/cost analysis is done, solar-powered traffic signals are not a solution in most cases.

The strategy we propose to address electricity interruptions at intersections is:
- Remove or do not install unwarranted traffic signals.
- Install LED lamps – this will provide an energy saving of approximately 6,72 MW.
- Starting at critical intersections, install battery backup of up to six hours.
- Finally, solar-powered sites can be installed at remote sites, typically at interchanges.

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<th>Table 6 Cost of battery backup alone</th>
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<tr>
<td>Item</td>
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<td>102Ah Deep-cell Battery</td>
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<td><strong>TOTAL</strong></td>
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AN ONGOING INITIATIVE of the KwaZulu-Natal Department of Transport is the social equity and black economic empowerment initiative, ‘Vukuzakhe’. According to Dheven Pillay of Makhaotse, Narasimulu & Associates (MNA), Vukuzakhe is a programme that focuses on wealth and job creation in communities that have been most disadvantaged historically. The initiative was piloted after 1994 as part of the Roads for Rural Development Programme and has resulted in more than 1 000 contracts being awarded annually to emerging contractors.

Dheven is a ‘hands-on’ civil engineer who spends a considerable amount of his time project managing and designing roads and storm water projects, while also engaging in mentoring initiatives that support emerging contractors. The Vukuzakhe Emerging Contractors Development Programme, requested by the KwaZulu-Natal Department of Transport, is therefore an initiative that lies close to his heart.

This programme is a multiple-staged advancement programme which facilitates the growth and development of small businesses. Each stage of advancement is characterised by higher levels of risk to the contractor and the removal of support mechanisms by the Department. The staged advancement programme is also designed to effectively remove barriers that prevent the full participation of emerging contractors in the road construction industry. Contracts are awarded only to contractors who are on the Department’s database and are awarded against set, negotiated or competitive rates.

MNA has been involved in one of the projects targeted under the Vukuzakhe programme, namely the upgrading of the P52 roads, in a consortium with Eyethu Engineers. Quality output was ensured by detailing all designs with the help of the infrastructure design software package, Civil Designer.

This project started in 2006 and required the surfacing and realignment of 28 km of road. Various contractors were commissioned to handle certain aspects of the project. This gave the larger contractors, who handled the bulk earthworks, opportunities for job creation, but also allowed smaller contractors, who handled the side drains or gabions, to benefit.

“Government initiatives seem to be moving more in the direction of road upgrading and the creation of formal roads in rural and township areas. This presents various opportunities for community involvement by which social issues are addressed. It is only when one interacts with the various PLC committees that one gains a true understanding of the harsh conditions that people live under,” notes MNA’s Dheven.

The road, which previously had a design speed of 60 km/h, has since been upgraded to an 80 km/h design speed. The feedback from site meetings has also revealed that the upgrade is contributing positively to communities. According to Dheven, MNA is committed to the future of the civil engineering profession and considers the imparting of knowledge under upliftment initiatives like ‘Vukuzakhe’ an important investment.
A full complement of TOSAS products for all-year-round application

TOSAS (PTY) LTD, a Sasol-affiliated company, is recognised as one of the largest and most trusted local manufacturers, suppliers and applicators of a wide range of superior quality products for African roads, and has been for close to four decades.

Meeting diverse applications ranging from road construction and rehabilitation to agricultural dam-sealing, as well as dust suppression, the TOSAS product range consists of bituminous products including anionic/cationic emulsions, polymer-modified bitumens, bitumen rubber, dam-seal, primers and pre-coats (Bitukote). TOSAS also conveniently supplies a variety of application-specific products off the shelf, i.e. bitumens and modified bitumens, bitumen emulsion and modified emulsions, dust palliatives, waterproofing and DIY products.

**Bitumen rubber**
Bitumen rubber is a high-performance binder that has earned a reputation for its superior properties of adhesion, flexibility and recovery from compression. It is one of the company’s flagship products and has been the binder of choice for surfacing seals in South Africa for 25 years, predominantly in the application of single and double seals on existing bituminous surfaced roads as resales and stress-absorbing layers (SAMs) or inter-layers (SAMIs). In addition to its role as a reseal product, bitumen rubber is also successfully used in southern Africa as a sealant for newly constructed roads, particularly in low-volume applications as the first seal of an intended multi-layer strategy.

Bitumen Rubber Asphalt Surface Overlays, known as BRASO, for asphalt applications is another area in which this versatile product is utilised. When bitumen rubber is used in asphalt, there is a higher percentage of binder in the asphalt mix. The bitumen rubber effects higher elasticity and toughness, and this provides better rutting resistance. Because of the increased binder content, the life of the bitumen rubber asphalt is far superior to that of conventional asphalt.

Some of the performance properties provided by bitumen rubber are as follows:
- Resilience and elastic recovery allows movement in active cracks or high deflections without fracture.
- Resistance to flow at high temperatures allows more binder to be applied to provide a thicker seal.
- The carbon black content in the rubber crumb has a shielding effect on the base bitumen which helps to prevent aging through exposure to harsh UV rays. TOSAS-manufactured bitumen rubber offers the excellent abilities of reducing the reflection of cracking through the new seal and of ‘re-healing’ itself. UV resistance is achieved by antioxidants in the form of carbon black in the rubber crumb. The function of a surfacing seal is to cover an old wearing course or base and provide an impermeable riding surface. To achieve a good seal the most binder possible should be applied without flushing or bleeding taking place. When bitumen rubber is used in single seals, it is possible to apply up to 60% more binder than in similar seals with conventional bitumen and other modified bitumen products. Bitumen rubber used in double seals yields up to double the normal binder application.

The benefits provided by the binder, such as an impermeable wearing course, crack resistance, good skid resistance and a long performance life, mean that bitumen rubber constitutes a cost-effective alternative to other surfacing seals and thin asphalt layers.

Bitumen rubber consists of bitumen, granulated rubber crumb and extender oils. The source of peelings and buffings is important since the ratio of natural and synthetic rubber in the manufacturing process has a highly significant influence on the behaviour of the final bitumen rubber blend. The relative reactivity of natural rubber is higher than that of synthetic and neoprene rubber. A high
natural rubber content means a greater degree of reaction between the rubber and the bitumen at high temperature. More natural rubber provides better elasticity and adhesion than would be provided by synthetic rubber and therefore a minimum of 25% by mass of natural rubber is required.

The morphology of the rubber particles is the most important factor. The surface area affects the degree of chemical reaction as large particles are functionally undissolved rubber floating in the bitumen and small particles form a large amount of gel. The compound bitumen rubber product is a matrix of gel, bitumen and resilient rubber which defies separation. Crumbed rubber also contains approximately 40% of carbon black, a natural antioxidant, which will substantially delay the aging of the bitumen rubber binder on the road.

Resealing with bitumen rubber does not have to be limited to the summer months; the resealing window can be extended into the colder winter months. The South African standard specifications limit seal work, using a bitumen rubber binder, to periods when the road surface temperature is 25°C and rising. Although the minimum overnight temperatures are not specified, a night-time low of 10°C is generally considered to be the minimum. These temperature limitations ensure good adhesion between binder and aggregate during the initial days of the seal when the risk of aggregate loss is highest. The effective sealing period is therefore limited to the summer months, i.e. October to April. Most southern African regions have summer rainfall and this also significantly reduces the actual sealing opportunities.

However, resealing with bitumen rubber does not in fact have to be limited to the summer months and the resealing window can be extended into the colder winter months. During the early 1990s, the bitumen rubber industry produced a product that could be used at temperatures below the recommended minimum of 10°C in order to extend the season. This was done by introducing a cutter into the bitumen rubber to reduce viscosity at lower temperatures in order to provide adhesion when temperatures drop to 0°C, depending on the quantity of cutter added. By varying the percentage of cutter in accordance with the season, it is possible to seal effectively throughout most of the year.
**Winter-Grade bitumen rubber**

For winter applications, a few simple guidelines need to be followed, such as using bitumen rubber containing the correct percentage of cutter, commencing a little later in the morning, i.e. between 9:00 and 9:30, to establish the correct road and air temperatures before application of the product, and discontinuing daily operations in the early afternoon, i.e. between 14:00 and 14:30. TOSAS has undertaken numerous successful projects, some dating back ten years, which clearly indicate the effectiveness of TOSAS Winter-Grade bitumen rubber.

As far back as May and June 1998, TOSAS successfully resealed the N14 between Potchefstroom and Klerksdorp with MC3000 and 13.2 mm single seals. This is an area where night temperatures dropped as low as 2°C and road temperatures did not exceed 21°C during the day. Nineteen years later, the surface of this busy road, which carries approximately 4 500 vehicles per day, is still in excellent condition. During May and June 2003 TOSAS resealed the P172/2 between Middelburg and Van Dyksdrift, which is the link between the coal mines and Duva Power Station, meaning that more than 45% of the daily traffic is heavy-duty coal trucks. A year later, resealing was done on the N4-3Y between Middelburg and Witbank and, more recently, in March 2008, TOSAS used their bitumen rubber Winter-Grade product to reseal the P51/2 between Middelburg and Stofberg. Reports indicate that all the road surfaces that were resealed in winter are still in good condition.

The table below provides a summary of four winter resealing applications with TOSAS Winter-Grade product.

**Other products**

TOSAS offers two emulsion ranges, namely anionic and cationic emulsions. The different emulsions are specifically designed to react and behave optimally to provide the best results for different applications. Bitumen emulsions are classified according to their break rate, i.e. slow set (slow break), medium set (faster break) and rapid set (quick break). TOSAS manufactures emulsions with various binder contents and the most popular products are those with binder contents of 60%, 65% and 70%.

The company’s product portfolio also includes five primers – RTH 1/4P, TOSAS QDP, TOSAS IBE, MC10 and MC30. In conjunction with Sasol Technology Fuels Research, TOSAS developed MC10, a cut-back bitumen-based product with lower viscosity, resulting in better penetration and faster drying. These factors enable the contractor to start surfacing construction earlier without the risk of pools or puddles of primer forming in depressions, which could negatively affect the subsequent properties of the seal or asphalt.

TOSAS-designed Bitukote offers an environmentally friendly alternative to tar-based precoats and is blended only from products certified as being in accordance with environmental requirements as prescribed by SANRAL (South African National Roads Agency Limited). Bitukote has been formulated to drench or coat all types of aggregate, as well as to ensure good adhesion to the stone, and may be used with aggregates of varying sizes under slightly dusty or damp conditions.

**Environmentally cognisant**

TOSAS was awarded ISO 14001 Environmental Certification in 1996. It was the first company in South Africa to receive this certification in recognition of its awareness of environmental issues. The full complement of TOSAS products is supported by an expert technical team that works closely with road authorities, consulting engineers and contractors, offers advice and sources the best possible bituminous product and/or application solution for the customer.

Johan Jacobs, TOSAS Marketing Manager, summarises: “With a combination of an extensive range of world-class products, a large, well-organised application division, an extensive supply network, technological know-how and impeccable services, TOSAS is capable of meeting even the most demanding applications and deadlines with confidence.”

<table>
<thead>
<tr>
<th>N14: Between Potchefstroom &amp; Klerksdorp</th>
<th>P172/2: Between Middelburg &amp; Van Dyksdrift</th>
<th>N4-3Y: Between Middelburg &amp; Witbank</th>
<th>P51/2: Between Middelburg &amp; Stofberg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous texture of road</td>
<td>4.75 mm grit seal done the year before with 80/100 pen bitumen</td>
<td>13.2 mm and sand seal done with MC 3000</td>
<td>13.2 mm</td>
</tr>
<tr>
<td>Traffic count on road</td>
<td>±4 500 vehicles/day</td>
<td>±5 500 (45% heavy vehicles/day)</td>
<td>±2 000 vehicles/day</td>
</tr>
<tr>
<td>Road temperatures</td>
<td>Between 15 &amp; 21°C</td>
<td>Between 18 &amp; 20°C</td>
<td>Between 11 &amp; 20°C</td>
</tr>
<tr>
<td>Day temperatures</td>
<td>Between 16 &amp; 25°C</td>
<td>Between 22 &amp; 23°C</td>
<td>Between 12 &amp; 20°C</td>
</tr>
<tr>
<td>Night temperatures</td>
<td>Between 2 &amp; 8°C</td>
<td>Between 2 &amp; -8°C</td>
<td>Between 2 &amp; -8°C</td>
</tr>
<tr>
<td>Application of binder</td>
<td>1.6 l/m² in slow lane &amp; 1.8 l/m² in fast lane</td>
<td>± 2.20 l/m²</td>
<td>± 2.00 l/m²</td>
</tr>
<tr>
<td>Stone application</td>
<td>0.10 m³/m²</td>
<td>0.12 m³/m²</td>
<td>0.03 m³/m²</td>
</tr>
<tr>
<td>ALD (average least dimension) of aggregate</td>
<td>8.5 mm</td>
<td>7.0 mm</td>
<td>8.50 mm</td>
</tr>
<tr>
<td>Flakiness</td>
<td>12.0 mm</td>
<td>16.0 mm</td>
<td>10.0 mm</td>
</tr>
</tbody>
</table>
Liviero, one of the country's leading privately-owned construction Groups, founded by the late Giosue Liviero, is celebrating twenty-five years of active construction in South Africa.

The roots of the company can be traced back to Zimbabwe in 1967 and, before that, to reounding in Mirano, Venice, Italy, in 1955. Luca Liviero, the Chairman, joined his father in the company in 1989.

While G. Liviero & Son Building Division anchored the Liviero Group for many years, the Civils Division and a significant complement of plant now make Liviero one of the most comprehensive construction companies in Southern Africa.

Having initially grown into a dominant force in the medium-size construction market in KwaZulu-Natal, Liviero is now firmly established in Gauteng, where it relocated its head office from Durban to Kyalami, Johannesburg, with regional offices now falling under its control.

“Liviero is succeeding in its commitment to operate as one of South Africa’s safest, most efficient contracting companies.”

Continuing to operate in KZN, Gauteng, Limpopo and more recently in the North West Province and Mpumalanga, Liviero successfully brings its expertise to bear in all aspects of construction work throughout South Africa.

Over the last quarter century, Liviero has developed a healthy track-record by offering unique turnkey solutions through its systematic and proactive process of value management.

The highly experienced directorate, dynamic management teams and a workforce numbering 1600 dedicated employees combine professional expertise, plant and equipment and financial strength to execute a wide range of construction contracts.

Liviero is succeeding in its commitment to operate as one of South Africa’s safest, most efficient and cost effective contracting companies. All sites in the Liviero Group are managed and audited externally with the provision of daily independent health and safety audits.

Liviero has established a long list of blue-chip clients whose expectations are constantly and consistently exceeded by an enthusiastic, motivated and dedicated Liviero team.
Liviero Building Company – The original foundation of the company

Since its inception, G Liviero & Son (Liviero Building Division) has established a reputation for reliability and technical excellence in all aspects of building.

Working in both the public and private sectors it has delivered successfully in the industrial, commercial and residential segments.

This division is responsible for the construction of office blocks, warehouses, shopping centres, institutional buildings, apartment blocks and residential complexes, design and build and alterations and additions.

Some of our successfully completed projects include: 12 on Palm, Olympic Towers, Polokwane Motor City, Standard Bank Regional HQ, KZN, Mool River Mall, The Core, Pick n Pay Distribution Centre, La Palma Terraces, Quays and Quayside, Millpark Mews, Chiarello Lifestyle Estate, Castello Private Estate, The Bay and Tamboti – Simbithi.

Liviero has successfully delivered over 2500 middle and upmarket residential units over the last few years.

Liviero was the first privately owned company to achieve a CIDB GB rating.

Testament to the continued success of the company, Liviero has received three awards from the KwaZulu-Natal Master Builders Association for 2008.

• Commercial Building
  (above R40m)
• Highly Commended
  Apartments
• Supreme Builders of the year
Liviero Civils Company – Now also a serious player in the market

The civils division of Liviero, Liviero Civils (Pty) Ltd was formed in 2005 and as a result of the superior expertise it has taken on board, it has already become a serious player in the market. It has worked successfully on the Sandton and Rosebank Gautrain stations, 2010 World cup stadiums and many other high profile contracts. Its services include roads and earthworks, bridge building, bulk earthworks, industrial concrete works and general civil engineering work.

The company currently enjoys a CIDB rating of BCE, which will move to BCE within the year.

The company is a Level 4 contributor in terms of the BBBEE scorecard.

In joint venture with four other contractors, Liviero Civils has recently been awarded two packages on the mega Gauteng Freeway Improvement Project.

- Roads and earthworks
- Bridge building
- Bulk earthworks
- Industrial concrete works
- General civil engineering
PLANT COMPANY – ACCESS TO THE RIGHT EQUIPMENT FOR THE JOB AT HAND

Liviero has always understood the benefit to the client of immediate access to the right equipment for the job at hand.

As a result, for the last twenty-five years the company has actively acquired an extensive range of building plant and equipment, (considered the largest in the country), including over 120 000m² of access scaffolding and support work, a fleet of 14 tower cranes and 12 mobile cranes and a vast array of equipment. This strategy of owning the assets rather than hiring, has continued in the civils business and has been beneficial to both Liviero and its clients. Going forward, and with current plant value in excess of R250m, this plant will continue to be the cornerstone of the success of the Liviero Group.

A high level of quality is ensured through the maintenance and servicing of all company vehicles and equipment at accredited workshops. With faulty equipment immediately repaired or replaced, this translates into minimized downtime and maximized efficiency for the client.

LIVIERO PEOPLE POWER

With its roots in a two-generation family concern, Liviero understands the need to develop skills that will position the company to meet changing needs and future challenges. The company has its own extensive in-house training programmes, which focuses on growing human resources and capital. Liviero also supports a host of bursaries and scholarships, proactively seeking the development of human capital into the future.

EMPOWERMENT

Liviero is entirely BEE compliant. In October 2007, Impaqo Building and Civils (Pty) Ltd, a respected Empowerment Business owned entirely by previously disadvantaged individuals, acquired a 30% stake in the Liviero Group of Companies.

Company directors are proud that the Liviero approach to enterprise development happen as a matter of course, with investment in black empowerment done with focused broad-based principles. The company is focused on developing its growth through the development of South Africans largely historically disadvantaged.

The next 25 years

With a current annual turnover of more than R1.4 billion, Liviero is now looking forward to its next twenty-five years of dedicated service.

The company is currently engaged in an exciting expansion programme. With the completion in the next few months of an additional 10000m² of office space at the company’s Kyalami head offices, Liviero continues to embark on national expansion and further diversification programmes. The company thrives on the reputation it has developed and is always increasing its fine client reputation.

The Liviero directors take this opportunity to thank all staff, subcontractors and suppliers for all their hard work, commitment and support, which has contributed towards the success of the group. Together we have all made the group a highly successful business machine, which is ready to take on the next 25 years.
ALTHOUGH FROM 1988 to 2000 the City Engineering Department of Roodepoort investigated the possibility of developing the farm Paardekraal in Soweto, this was never realised due to difficulties experienced with bulk engineering services in the area. The site was also zoned as mining land and later rezoned as industrial land. Due to the high demand for low-income housing in Gauteng, the process of rezoning the land as residential commenced in 2005 when the Pennyville Extension 1 project was launched.

The project resulted from a land exchange agreement between Pennyville Zamimphilo Relocation Pty (Ltd) (PZR) and the City of Johannesburg Metropolitan Municipality (COJ). This agreement required PZR to develop the Pennyville land on behalf of the COJ’s Department of Housing and, in exchange, PZR received the Riverlea Extension 3 land on which all civil engineering services had been constructed by the Northern Metropolitan Local Council in the 1990s. Riverlea required limited upgrading and maintenance of the roads and storm water infrastructure in order to market and build bonded houses on the development.

EXTENT OF THE PENNYVILLE PROJECT
The Pennyville Extension 1 property is 99.5 hectares in extent and consists of 1 117 RDP-type units on Residential 1 stands and 1 693 units in two-storey and three-storey buildings on Residential 3 stands. The Residential 3 stands are being registered as Section 21 companies under the names of the Johannesburg Social Housing Company (Pty) Ltd (JOSHCO) and ABSA, who will manage the units as ‘rental stock’ to the public.

The layout also makes provision for one school site, three crèche sites, one business site and five public open space sites.

PZR appointed a professional team of consultants and contractors to assist them in implementing the project. As there was some urgency to the project, it had to be undertaken in four phases in order for design and construction work to run concurrently.

The scope of works for the construction of all civil engineering infrastructure was as follows:

- one signalised intersection with New Canada Road to give access to phases 1 and 2
- 7 500 m of roads, 7 m, 6 m and 5 m wide, which would be bitumen-surfaced, with kerbs, and a combination of storm water channels and pipe systems
- 3 800 m of paved access strips, 2.4 m wide
- 3 500 m of pedestrian paths along main routes in all phases
- one storm water attenuation pond per phase
- 11 640 m of internal water reticulations and 10 228 m of sewer networks
- 1 187 m of link sewers and the upgrading of the existing Noordgesig link sewer from a diameter of 160 mm to 200 mm
- upgrading of the existing Noordgesig bulk water meter, pressure-relief valve

Pennyville Extension 1
A new benchmark project for low-cost housing developments

An aerial view of Pennyville Extension 1. The three-storey buildings are nearing completion.

Ronaldt Vosloo
Bigen Africa Services (Pty) Ltd
ronaldt.vosloo@bigenafrica.com
and associated fittings from a diameter of 100 mm to 150 mm (belonging to Johannesburg Water (Pty) Ltd (JW))
■ new bulk water connection (300 mm diameter) for Rand Water (Pty) Ltd (RW), including meters, pressure-reducing valves and associated fittings and chambers
■ cathodic protection for the new steel link water pipeline (350 mm diameter) and RW/JW valve chambers
■ 4 238 m of boundary walls around all phases of the development
Other projects that form part of PZR’s contract with COJ are the construction of a new outfall sewer (2 km long) with diameters ranging between 160 mm and 600 mm to serve phase 4 and future developments to the north of phase 4, and a pedestrian bridge over New Canada Road to link the Pennyville community with the New Canada Metrorail station and the future Bus Rapid Transit (BRT) station on New Canada Road. The environmental impact assessment process is reaching completion, with the Record of Decision expected by September 2008 for the outfall sewer and the pedestrian bridge having gone out on tender at the end of August 2008. The design of the realigned New Canada Road, including the BRT and the civil services for the BRT station, has also been completed.

The project is funded by COJ’s Housing Department through the Municipal Infrastructure Grant and has a construction value of approximately R60 million, excluding VAT and professional fees.

**PEDESTRIAN ACCOMMODATION**
One of the main objectives of the town planning approach was to create a pedestrian-friendly development where the community would be able to move around freely with a limited risk of being run over by motor vehicles. The main aim was to utilise to the full most of the areas between houses for pedestrian movement.

This was done by limiting the number of 5 m wide internal roads and constructing 2.4 m wide access strips between rows of houses. A typical block with four rows of stands will have three access strips between the rows of stands to link pedestrians and the occasional vehicle to the 5 m wide internal roads. In order to accommodate storm water between the houses, the access strips were constructed with 60 mm interlocking paving blocks to a V-channel shape with a 3% fall to the centre of the strip. The storm water is discharged onto the internal roads at the end of the access strip, from where it is drained to a storm water pipe or channel leading to an attenuation pond. The access strip creates the impression of a private walk or driveway to the houses and is shared by the inhabitants of the two rows of houses. Due to the low-income nature of the development, the access strips are used almost exclusively by pedestrians, thus creating a safe environment for children to play around their houses.

Since public transport will be the major transport mode used by residents, pedestrian paths were constructed along all the main routes to lead pedestrians to the intersections with New Canada Road and the pedestrian bridge over this road. During peak periods, nearly 4 000 commuters will access public transport at various locations near Pennyville, most notably at New Canada Metrorail station, along New Canada Road and at the BRT station, which will be accessible from the pedestrian bridge.

To make it safe for pedestrians to walk along the walkways at night, street lighting has been provided along all walkways on both sides of the road.

In order to discourage the community from going onto the adjacent N17 freeway, New Canada Road (class 3 minor arterial) and the railway reserves, walls are being constructed along all the boundaries of Pennyville.

**CHALLENGES**

**Existing outfall sewers**
The link sewers of each phase drain to four different locations where they discharge into the Klipspruit relief outfall sewer, the minor drop structure number 1 of the Bushkoppie outfall sewer and the Noordgesig link sewer. One of the prerequisites of JW before they would approve the township application was that it had to be proved that these sewers possessed the available spare capacity. A sub-contractor was appointed to do ultrasonic flow depth measurements which were then used to determine the existing flow rates and available spare capacities. The existing below-ground steel Klipspruit relief outfall sewer into which phase 4 would discharge had to be inspected by means of closed-circuit television (CCTV) and jetted clean of any evident blockages before the link sewer of phase 4 could be connected to it.

**Developing on rock outcrops**
The site is underlain primarily by relatively shallow quartzite bedrock of the Witwatersrand Supergroup which outcrops in phases 3 and 4 of the development. Due to the 80% to 95% rock in phases 3 and 4, a shortage of bedding material for pipe trenches was experienced. To solve this problem, excavated material from the storm water attenuation...
ponds of phase 1 and from a small borrow pit on the school stand in phase 2 were used as a source for bedding material and topsoil for finishing on the road reserves. The borrow pit had to be backfilled and rehabilitated at the end of the project. Blasted rock was processed by a mobile crusher plant on site to obtain material for the base and subbase pavement layers of selected roads.

The rocky areas of phase 4 meant very expensive service crossings for the two RW pipelines of 1 400 mm and 1 100 mm in diameter respectively. Controlled blasting near the RW pipelines was one of the critical safety aspects in which the measurement of seismic activities played an important part.

Two contractors

Having two contractors (civil and building) on the same site simultaneously posed a challenge in itself, with integrated planning, possible damage to infrastructure during construction and control of stand pegs being subjects for regular discussion during site meetings. In retrospect one can say that the effective management of the two types of contractor is a very important aspect that can influence the successful implementation of a project and should not be underestimated during site supervision.

PROBLEMS ENCOUNTERED AND INNOVATIONS

Sealing of mine shafts

A portion of phase 2 includes a mining belt on which mining was practised in days gone by. The areas suspected of being undermined are zoned as public open space and the storm water attenuation pond for phase 2 is located on a portion of the undermined area. While excavations for the storm water attenuation pond and storm water pipe trenches were going on, three abandoned inclined mine shafts were exposed. These shafts were inspected by a senior inspector of mines from the Department of Minerals and Energy who declared it safe to seal the shafts. Guidelines for the permanent sealing of mine shafts, according to the Mine Health and Safety Act, 1996 (Regulation 5.6.1), were followed in designing the sealing of the shafts. Two reinforced 28 MPa concrete slabs, 450 mm thick, were cast into the surrounding bedrock with backfill material being compacted on both sides of the slabs.

Extension of sewer breather pipe

The minor drop structure of the Bushkoppie outfall sewer is also situated on phase 2 of Pennyville and was designed to give the surrounding areas an access point for discharging sewage into this outfall sewer tunnel, which is up to 30 m deep in certain sections. An existing breather pipe for ventilating the structure caused an unpleasant smell and posed a health hazard to the adjacent crèche stand, which resulted in the pipe being extended to make it 5,5 m high.

New Canada Road

New Canada Road traverses Pennyville between phases 2 and 4 and will be rea-
aligned vertically and horizontally due to insufficient sight distances and to ensure safe access to Pennyville, the future N17 freeway that will cross below New Canada Road, and the additional road widening required for the implementation of the BRT project. The N17 freeway will traverse phases 3 and 4 of Pennyville.

New Canada Road is part of the BRT route currently being upgraded by the Johannesburg Roads Agency (Pty) Ltd (JRA) and the Johannesburg Development Agency (Pty) Ltd (JDA) on behalf of the COJ. The aim of the BRT project is to encourage commuters to make use of the BRT transport system and help alleviate the traffic congestion that the city is currently experiencing.

It includes the two centre lanes that will become dedicated bus lanes with bus stations placed strategically in the centre of the road.

At this stage it is almost certain that the realignment of New Canada Road and the two roads giving access to Pennyville will be constructed by the contractor appointed for the N17 freeway, as soon as a variation order for the same is approved by the COJ and the South African National Roads Agency Limited (Pty) Ltd (SANRAL). SANRAL has appointed the Nasweto Highway Joint Venture for the construction of the N17 freeway, the upgrading of Nasrec Road and realignment of New Canada Road.

Different design and construction phasing between Pennyville and the N17 (and New Canada Road) resulted in a four-month construction delay for Pennyville due to a scope overlap that could not be finalised in time by the authorities.

The completion of New Canada Road is expected only towards the end of 2009. A bypass road through phase 2 of Pennyville will ensure safe access to phases 3 and 4 while New Canada Road is under construction.

**SETTING NEW STANDARDS FOR LOW-COST HOUSING DEVELOPMENTS**

PZR planted trees and grass around all the houses in the development, with the aim of uplifting the community’s morale and setting a new benchmark for low-cost housing developments.

**Storm water design**

Storm water accommodation is one aspect of the civil services that makes Pennyville stand out above other low-income developments as acknowledged by the representative of the JRA in the area when he indicated, “Pennyville certainly has the most impressive storm water system I have ever seen in low-cost developments.”

The minor and major storm water drainage systems were designed to accommodate 1 in 5 years and 1 in 25 years design floods respectively. The system is a combination of surface and underground pipe systems that collect storm water on roads, at low points and, where justified, before the intersections of roads. These pipe and surface systems connect to storm water attenuation ponds before discharging.
into streams adjacent to the development. The aim is to prevent flooding or damage to adjacent property, as well as to allow emergency vehicles to travel on internal roads.

**PROJECT PROGRAMME AND COSTS**

Construction of the civil engineering services commenced on 31 July 2006. The scheduled completion date of 30 November 2007 was extended to 16 May 2008 due to the unfinalised planning issues regarding New Canada Road and the BRT. The total construction costs of the internal and bulk roads and the services for Pennyville amount to R35 million and R24 million (excluding VAT) respectively. The planned commencement date for construction of the pedestrian bridge is November 2008 and it has an estimated construction value of R5 million. The New Canada Road realignment has an estimated construction value of R73 million, which includes the bridge over the N17 freeway, and will commence as soon as a variation order has been issued to the Naswete Highway Joint Venture.

**CONCLUSION**

Developing this low-cost housing development on rezoned mining land proved to be challenging, but has also turned out to be a very successful project by the COJ Housing Department and its implementing agents. Pennyville is proof that it is possible for private companies and government to work together in unconventional agreements to effectively reduce the backlog in low-cost housing and to create a low-cost development of high quality.

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**PROJECT TEAM**

**Client:** City of Johannesburg, Department of Housing  
**Developer/Turnkey contractor:** PZR (Pty) Ltd  
**Town planner:** CTE Regional and Town Planners  
**Consulting engineer:** Bigen Africa Services (Pty) Ltd  
**Civil contractor:** Civtek cc  
**Building contractor:** Sea Kay Engineering Services (Pty) Ltd

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Pennyville is proof that it is possible for private companies and government to work together in unconventional agreements to effectively reduce the backlog in low-cost housing and to create a low-cost development of high quality.
Largest precast retaining wall element to date in South Africa – for The Houghton

THE CONSTRUCTION of The Houghton, a development comprising two luxury residential apartment blocks (Houghton 1 and Houghton 2) and a 180-room boutique hotel development (Houghton 3), involves South Africa’s largest deployment of precast hollow-core concrete panels as retaining walls to date.

Spanning approximately 2 000 m at an average height between 3,2 m and 5,0 m, the panels are fulfilling a dual role of retaining embankment soil and providing walling for parking basements and below-ground level service areas.

Supplied by Concrete Manufacturers Association (CMA) member, Echo Prestress, the prestressed panels were manufactured in standard 1,2 m widths varying in length from 3,2 m to 5,0 m. Panel thickness was a standard 150 mm in most instances, except where two slabs, one on top of the other, were required to accommodate embankment depths of up to 10 m, and in these instances panel thickness was increased to 250 mm.

The precast slabs used on Houghton 2 were between 3,2 m and 4,1 m, whereas in the cases of Houghton 1 (residential) and Houghton 3 (the hotel) where the contours are more severe, there was a much greater variance in slab length.

Rogan Duffy of Pure Consulting, the consulting engineers responsible for the project’s structural engineering, says that where possible the objective was to achieve as much standardisation as possible in panel sizing to render their manufacture and on-site deployment as simple as possible.

Foundation support for the Echo panels was provided by 250 mm deep footing channels. Additional lateral support was achieved through thickening the edge of the surface bed on the support side of the footing channel to 300 mm, thereby lifting the height on that side of the channel to 550 mm. Moreover, a fully cantilevered application was avoided by bolting small right-angled steel sections to the first floor slabs. These provided the head of each panel with additional support.

“In some instances we have done away with the steel angles and have allowed the Echo panels to rest against the first-floor slabs. The first floor slabs receive no support from the panels and instead rest on concrete columns situated inside the basements,” says Duffy.

The reason for opting for the footing channel support method is that it is very cost-effective. It is very similar to the footings that are used for the project’s brick walls which, because they are curved, are not suitable for Echo panels unless the aim had been to create a faceted wall. Furthermore, by integrating the surface bed into the support channel, on-site productivity was improved significantly.

The channel or recess which provides foundation support to the panels was constructed in the same manner as any standard footing. Before the concrete was poured, a steel reinforced cage and a metal wedge were inserted into the trench. Once the concrete had set, the metal wedge was removed, yielding a support channel with very smooth chamfered edges.

As with most building projects a key objective was construction speed, and in this instance the use of precast panels meant that the retaining walls were generally erected three times faster than
in situ construction would have taken. According to Duffy they wanted to have the retaining walls erected before the casting of the first floor slab in order to improve access for the main contractor, Murray and Roberts.

As a result, Murray and Roberts has been able to lay about eight linear metres of walling a day in either brick or reinforced concrete, and the panel contractor, Echo Prestress, has achieved in excess of 30 m to 35 m of prestressed paneling erected each day without any significant involvement from Murray and Roberts.

Approximately 98% of the retaining wall requirement on the Houghton project comprised Echo precast panels. In some instances, however, it was not possible to use the panels, owing to on-site geometry. On walls with tight radii, for example, in situ concrete or brickwork was chosen. As it turned out brickwork was used in most of these instances.

Another advantage of Echo’s panels is that they are very easy to cut, for example in creating space for the installation of air-conditioning units. The friction between the concrete and steel reinforcing in a prestressed panel ensures that the tension and structural integrity of the panel are retained after cutting.

The Houghton is being developed by ASVID Holdings, a company headed by Irishman David Nagle, an international property developer with other property interests in South Africa. Besides the 180-room five star hotel, the development will see a total of 320 high-end apartments being brought onto the market.

Architects Boogertman & Partners have designed Houghton 1 and Houghton 2 with considerable internal design flexibility. Apartments which begin at 190 m² and rise to 350 m² could be combined to form single units where required. Units could be combined horizontally or vertically and each would have a balcony with a spectacular view over the Houghton Golf Course.

The development includes a luxury spa and gym, and the golf course is being upgraded by world-renowned golf champion, Jack Nicklaus. A new club house is also being built in the middle of the course.

Construction work on The Houghton began in January. The hotel and the bulk of the apartments are due for completion at the beginning of 2010. However, some apartments will come on stream and be ready for occupation as early as April 2009.

ENQUIRIES

John Cairns
011 805 6742

(Photographs: David Beer)
Essential business knowledge for engineers and technologists

As I work with clients seeking to achieve maximum value from their investment in business information systems, I regularly encounter situations where specialists working in the field of information technology (IT) are sincerely engaged in doing things that are actually damaging and obstructing the business.

Over the years I have evaluated numerous situations and I have concluded that there are some essential principles of business that are so innately understood by successful business people that they do not think of communicating them to the IT people. After considerable thought and examination of my observations, I concluded that there were seven broad categories of knowledge, experience and other attributes that should be taken into account.

After all, why do organisations exist in the first place – to create opportunities and employment for human beings, or to reduce the head count?

More recently, as I observed the state of technology in South Africa and the interaction with society at large of policymakers and those working with technology, I concluded that these principles are relevant to other technical disciplines in addition to IT, hence this article on the essential elements of business knowledge.

1 Every organisation has a fundamental reason for existing

Strategy is fundamental; it is the essence of why an organisation exists and how it thrives – the why, what, how, etc. of business and government. For example, the essential reason why government exists is to do on behalf of the citizens of the country, province or town that which the citizens cannot do independently. Government is essentially a collaboration by the citizens to achieve objectives (such as the provision of roads, water, policing, defence, justice, etc.) that are necessary for stable, thriving communities. Everything that government does should be tested against this criterion.

In considering strategy and the essence of why an organisation exists, it is important to note that there are various drivers of strategy, such as how we generate and use money, how we utilise people, etc. It is vital in designing any business solution to understand and prioritise these drivers and to use this knowledge to focus everything involved in the solution.

The experts tell us that strategy is constant, but objectives evolve. The business environment and markets evolve. Plans are implemented, creating new opportunities for further improvement. It is important to understand what is constant and what is changing.

2 Money is only a medium of exchange and measurement

Goals are frequently set in financial terms, but money is after all only a medium of exchange and measurement. It is a proxy or surrogate for value. Money is a measure of performance, a measure of perceived value by people. Profit and productivity result from this perception of value. Money is easy to measure because it really is an instrument of measurement.

Strategy and competitiveness determine money yield and require other measurements. For example, the music, fashion and jewellery industries are three highly profitable areas of human endeavour when measured in financial terms. However, the value that results in this high financial return is very difficult to quantify. What is it about a song that propels it to the top of the hit parade, generating wealth for those who are...
instrumental in bringing it to market? The value that is exchanged between the performer and the consumer, facilitated by the producer, marketer, distributor and many others, is intangible and very difficult to quantify. Money is used as a means of measuring this value but is frequently an inexact and perfunctory measurement as evidenced by the number of artists who die in poverty, yet are judged by subsequent generations to offer enduring value.

Writing as an engineer for other engineers, I think this is true of much of what engineers do: they toil long hours to deliver work of exceptional quality and reliability, yet are frequently not valued in a manner that is commensurate with the long-term wealth that the products of engineering create for the communities they serve.

The current electricity crisis is a case in point. If there was a real appreciation for the true value that reliable and sustainable electricity supply brings to a nation, there would have been no shortage of funding from government for new generating capacity in the past decade.

3 Only humans create, destroy and determine value

Things only have value if a human being is willing to exchange (pay) for them. Things themselves are inert; value is determined by what people do with the things or think about the things.

By way of example, a gun in and of itself is neither good nor bad. A gun pointed at you by someone you regard as bad is bad, while the same gun pointed at someone you regard as bad by someone you regard as good is good. It is what humans do with technology that determines the value of that technology, not the technology itself.

Again, a stethoscope is without value until used by a person trained in how to interpret the sounds that it magnifies and translate these into a diagnosis which leads to health-supporting action. Thus it is vital to contextualise that which we as engineers do relative to what human beings will do when using what we create.

4 Ways of ‘being’ either create or destroy value

The factors here are:

- leadership, empowerment, delegation, loyalty, morale
- accountability, responsibility, trust
- self-discipline, commitment
- care, compassion, love, humanity, generosity
- esteem, ego, acceptance, recognition
- safety, security, health
- faith, belief, morals, values, religion, etc.

These so-called ‘soft’ issues are the essence of what a person gives to an organisation that creates value, and the essence of what a person seeks from an organisation – how they actually are. It’s implementations, or indeed any endeavours, that destroy or weaken these attributes can destroy long-term corporate value and competitiveness.

Many engineers regard a lot of these attributes as irrelevant or inconsequential whereas, in fact, they are what distinguish commercially successful technology solutions from unsuccessful solutions. In many cases, exceptional marketing of mediocre engineering solutions generates greater sustainable wealth than does mediocre marketing of exceptional engineering solutions. Yet most engineers disregard these factors.

5 Ways of ‘doing’ either create or destroy value

The attributes and factors involved here are:

- knowledge
- experience
- planning, analysis, design
- method, process, standards
- problem solving, creativity, initiative
- systematic, disciplined, diligent, making a productive contribution
- communication, language, writing skills, etc.

Together these form the ‘technology’ and capability that the person supplies to the business, organisation or nation. These skills are the essence of what we as engineers are schooled in and what we deliver to society, yet, in the absence of some of the other factors outlined in this article, these skills are frequently undervalued.

As a technical person, if you desire to prosper, it is vital to be in some material way associated with someone who is able to translate the value that you deliver into terms that the customer can understand and perceive as valuable. This will lead to the exchange of currency referred to above.

6 Servicing or supplying to others creates exchangeable value

Organisations consist of human beings and they exist to supply products or services to other human beings who consider those products or services to be of value. The value transaction is frequently based on money or time; there must be an interaction between two parties, one of whom supplies a product or service in exchange for money or another measure of value from the other party.

In a barter environment money is not necessary. However, money is convenient because it allows us to sell our products or services to one party and use the money we obtain from that transaction to purchase other products or services from another party. This provides flexibility for trading purposes.

In order to create this exchangeable value, it is vital to understand what customers and markets consider to be of value. Visionary engineers and inventors create solutions to problems that the market does not realise or understand that it has, and these people therefore find that they cannot sell their solutions profitably.

In our current society engineers understand the vital importance of well-designed and well-maintained water supply, roads, sewerage systems, electricity supply, etc. However, most of our society does not understand how vital these services and systems are to sustaining a vibrant economy and, consequently, we are seeing a shortage of electricity, defective sewerage systems, deteriorating roads, etc. because the true value of reliable infrastructure is not understood by those responsible for policy formulation and implementation.

Thus, instead of recognising a communication problem, many engineers have left or are planning to leave South Africa to the detriment of the long-term prosperity of all our people.

In the early days of my engineering career I regarded selling as something distasteful and dishonest. After all, I was quite capable of discerning the value of something and making a sound buying decision, wasn’t I?

Today, I have come to understand that true selling (as opposed to dishonest or hard selling) can be defined as helping a customer with a genuine need to purchase a product or service that truly satisfies that need.

7 The rest factors

- Technology, assets, etc.

Although they are substantial components of funding from government for new generations to offer enduring value.
ponents of most organisations and the primary focus of many of them, technology and assets cannot by themselves create or destroy any value, except through the interaction of human beings with that technology or asset. Consider the examples of the gun and the stethoscope referred to earlier.

CONCLUSION – What is essential business knowledge?
Understanding the above factors is critical to identifying and executing IT projects that deliver real value. Ignorance of these factors is a major reason why IT projects fail outright or fail to deliver material business benefit.

These basic principles were not taught as part of my engineering degree. In fact, they were not taught formally at any period during my time at educational institutions and, as far as I know, they are still not taught as part of formal curricula. This lack in formal education (coupled with the lack of education in the management and application of finances, and other fundamental principles that are essential to prospering in a technocentric society such as ours) seriously compromises the ability of many to prosper. More emphasis on the ‘soft’ issues as part of engineering studies appears to be warranted. After all, the attitude of a person who is resisting change can be more solid than the hardest block of concrete!

Engineers should note the huge irony associated with the points made in this article. Let us elaborate. It is possible to be technically the best engineer there is in a particular field; it is possible to work long hours and produce meticulous solutions that work highly effectively and yet find that you are struggling to survive financially because either other people do not want the outcome of your creative energies or else no one has sold this outcome to them, i.e. no one has helped them to buy in a constructive manner.

Engineers thrive when they are in partnership with people who can assist others to grasp the value that is on offer and who can assist the engineers to temper their endeavours and focus their energies on those activities that others perceive to be valuable.

This is a huge challenge for South Africa today. The exodus of experienced engineers reflects a harsh reality – our society does not grasp the great economic value that robust engineering capability brings to a nation. If we all did so, government would cease to take policy decisions and pass legislation that is driving engineers to seek employment in economies where their value is better recognised and it would take measures to incentivise engineers to build their future here.

The converse of this point is that engineers who are truly committed to this country and are passionate about staying need to partner with those who can assist government to understand that South Africa will only uplift the entire population by growing the base of engineering endeavour and by doing everything possible to make it attractive for engineers and other technical experts to remain here and thrive as critical contributors to a prosperous South Africa.

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1. WASTE MATERIALS: 
THE EARLY AND MIDDLE 1970s

Industrialisation and mining in South Africa have brought with them not only the usual and obvious benefits, but also a few potentially detrimental developments, of which the most visible and obvious examples are large and often unsightly dumps of apparently useless waste material deposited variously on grasslands, potential farmland and even on open spaces in built-up areas. In earlier days this disfiguring of the landscape might have been regarded as a sign of progress (‘where there’s muck, there’s money’), but in the age of environmental awareness the waste producers are required not only to maintain their dumps neatly and ensure the safety and health of the public, but also, if at all possible, to put the waste materials to some beneficial use.

The object of this article is to report on investigations that were conducted some years ago to look into the possible use of a limited number of such waste materials – in this particular case essentially as building materials for the civil engineering and building industries. In retrospect, the programme revealed a measure of interesting results and information, but produced no positive gains or profits either for its promoters or for the owners of the wastes. Nevertheless, a critical assessment of the planning and management of the programme could possibly be of some use in tackling a problem that is likely to be addressed with somewhat more urgency in the future.

Brief history of the programme

In the early 1970s, a recently merged South African/French construction company, Reef Lefebvre (RL), was persuaded by its French partner, Entreprise Jean Lefebvre (EJL), to look into the matter of unused or under-used wastes. EJL had played a leading role in France in the exploitation of industrial waste materials for the construction of roads and airports, and South Africa appeared to offer promising opportunities.

The RL venture, however, did not allocate a high priority to the programme – construction matters always came first – but it did succeed in carrying out a number of relevant activities and investigations over the years, amongst others:

- Laboratory trials at EJL’s Dourdan research facility in France, Wits (University of the Witwatersrand) Civil Engineering in Johannesburg, and the National Institute for Transport and Road Research (NITRR, part of the CSIR) in Pretoria
- Visits to EJL projects in France, and also to Scunthorpe in the UK
- Visits, talks and inspections at Eskom power stations, Iscor and Dunswart steelworks, Samancor works, Sasol and a few gold and coal mines
- Presentation of papers by consultants to the programme – Prof Geoff Blight
A few projects – major and minor – have indeed been initiated to extract residual gold at some of the older Witwatersrand dumps, but little effort has been spent over the years in attempts to exploit the vast available quantities of deposited fine tailings for some other beneficial use. In any event, the gold law places restrictions on the exploitation of dump material for any purpose other than further gold extraction.

(Wits) and Charles Digue of EJL – at conferences held in Pretoria and Paris at the time of inception of the programme, South Africa’s major producers of industrial and mining wastes were:

- Gold and platinum mines that annually extracted in excess of 120 million tons of hard rock, converted to fine tailings in the reduction processes
- Iscor and other smaller steelworks which produced blast-furnace and electrolytic slags
- Eskom’s coal-fired power stations and Sasol’s oil-from-coal plants which together produced annually in the order of 50 million tons of flyash

From the earliest mining days, waste rock had been crushed and processed to provide aggregates for building and construction, and had thereby fulfilled a valuable double function by producing the raw material at comparatively low cost and diminishing the need to locate and open rock quarries. Aggregate-production activities, however, could absorb only a small proportion of the rock brought to the surface, most of the balance having to be milled to fine proportions during the reduction process. Nevertheless, the resulting large volume of residue from reduction works had to be disposed of and was accordingly deposited into ‘dumps’, virtually the size of small hillocks, which eventually formed a feature of the landscape in all the main gold mining districts.

A few projects – major and minor – have indeed been initiated to extract residual gold at some of the older Witwatersrand dumps, but little effort has been spent over the years in attempts to exploit the vast available quantities of deposited fine tailings for some other beneficial use. In any event, the gold law places restrictions on the exploitation of dump material for any purpose other than further gold extraction.

Furthermore, the fine grading of gold mine tailings probably renders them unsuitable for large-scale use in the building and construction industries, except as a possible bulk fill. The RL programme therefore devoted little time or effort to the dumps and concentrated its efforts principally on flyash and slags.

In regard to steelworks wastes in general, a significant development had already taken place a decade earlier. Water-cooled blast-furnace slag, produced at the various Iscor iron ore reduction works, was milled to cement fineness in order to produce a latent hydraulic cement (termed ‘slagment’) that, when blended with Portland cement, became widely accepted in the cement and construction industries. Slagment soon became popular also in road construction for the stabilisation of soils and gravels, blended with either Portland cement or hydrated lime.

Iscor made no other concerted move to exploit their slags, other than somewhat limited use of blast-furnace slag which, after removal of residual iron, was crushed and then used as a coarse aggregate in civil engineering and building. In this case, EJL pointed out that in France extensive use was being made of iron ore slags in road building, but not simply as an aggregate for concrete. By virtue of their slags’ chemical properties, French practice was to stabilise them with either lime or cement in order to produce strong and economical subbases or base courses which met the specifications for most heavily trafficked roads.

Regrettably however, the concept again struck a snag in South Africa by virtue of the chemical content of Iscor slag. In laboratory tests, Iscor slag proved less reactive to stabilisation than its French equivalents for the reason that, in the South African reduction process,
French product, in the hope that local lime might have been the problem and not the flyash itself. However, the tests showed no significant difference between the two sources of lime, and the unsatisfactory performance of the Eskom ash was eventually attributed to its having too high a silica content, derived in turn from the poor quality of coal used at the power stations.

Blast furnaces use dolomite (calcium-magnesium carbonate) as a fluxing agent and not limestone (calcium carbonate). The projected slag programme, far less hopeful than expected, was therefore abandoned.

Having rejected mine sands and lost hope for slag, RL was therefore obliged to devote most of its attention to the possibilities of flyash. EJL had established itself as a leader in that field, in particular in the development of lime/flyash premixes for subbase and base layers. The NITRR in Pretoria was at that time already showing signs of losing its buoyancy, the entire programme petered out and was finally abandoned.

Both sets of research, however, again produced disappointing results. Flyash/lime mixes using Eskom ash could not achieve the performance obtained from equivalent mixes using French power station flyash.

EJL at first thought of comparing South African hydrated lime with the French product, in the hope that local lime might have been the problem and not the flyash itself. However, the tests showed no significant difference between the two sources of lime, and the unsatisfactory performance of the Eskom ash was eventually attributed to its having too high a silica content, derived in turn from the poor quality of coal used at the power stations. Eskom coal is supplied directly to the power stations from underground, is plentifully available at short haul distances and is successfully used for power production. Pretreatment of the coal is not required. South Africa does also, however, conduct a thriving coal export industry, although all coal for export needs to be washed and processed before acceptance by foreign customers. In fact, according to EJL at the time, South African coal produced satisfactory flyash when used in European power stations. But Eskom coal could not have been expected to alter its coal sources, which at that time were helping to produce cheap electric power, for the sake of producing an acceptable flyash. The programme had therefore struck another snag.

Since that time, a positive development in the commercial exploitation of flyash has come to light in South Africa. Only a few years after the end of the RL programme, a South African company, Ash Resources, has succeeded in marketing flyash, although in this case in the cement industry as a cement extender. The usual reasons for this success are given as: (i) Ash Resources extracts its product in a dry state directly from the precipitators in the power stations; (ii) it carefully selects power stations as its potential sources of flyash; and (iii) its flyash is blended with cement and not with lime.

All flyash tested in the RL and NITRR trials was, however, taken from hydraulically placed ash dumps. This followed EJL practice in France and the use of dry precipitator ash was never contemplated. Hydraulic placing did not seem, in any event, to affect the Pozzolanic properties of dump flyash in France. The failure of the programme was therefore regretfully and eventually attributed to the quality of Eskom flyash. Activation with cement does not seem to have been considered by either RL or the NITRR, possibly because of cement’s higher cost at that time in relation to lime. In any event, shortly afterwards the disappointing results brought both programmes to an end.

But RL did make a last effort in their flyash campaign, this time in Johannesburg where the City Engineer’s Department was faced with the task of street building in their rapidly growing urban ‘townships’. Charles Digue, EJL’s most experienced engineer in the particular field, designed a mix using mine dump tailings and a flyash/lime (or cement) mix as stabilising agent, and RL suggested experimenting with it on a trial length of road. (It is interesting that Digue did not at that time preclude the use of cement.) Negotiations for a trial failed, however, to obtain approval, which virtually put a stop to all enthusiasm and the Johannesburg project was carried no further.

Towards the end of the 1970s, when the South African construction industry was already showing signs of losing its enthusiasm, the entire programme petered out and was finally abandoned.

Discussion and comment

- It was probably correct policy, at the start, not to rush headlong into the programme. Nevertheless, once RL had decided that exploitation of waste materials might lead to commercial possibilities, and especially in view of EJL’s successes in France, a more conventional approach should have been adopted. This would have required, without incurring great expense, an action plan, budget of expenditure, appointment of a project champion and obligation to report back regularly. Without such a formal sense of purpose and setting of priorities, the project was allowed to drift into discussions, conferences, site visits and laboratory investigations.

- The South African arm of the company was completely inexperienced in R&D procedures and, in any case, with no extra staff having been taken on for the flyash programme, was being kept fully occupied in coping with the surge of conventional work then at hand. Its general approach to the ‘wastes’ programme therefore became somewhat perfunctory.

- On the other hand and after having initiated the concept, EJL themselves failed to acknowledge or realise that their partner lacked the expertise and enthusiasm to follow through on R&D projects. They should either have arranged for a South African engineer to spend some time gaining expertise or experience in France or otherwise have sent one of their experienced engineers to take over the project.

- RL made insufficient efforts to establish contact with senior technical officials or owners of the various waste materials – Eskom, Sasol, Iscor and the mining groups. EJL, in particular, must have known that there was no point in doing research on Eskom
flyash or Iscor slag without some formal pre-agreements in regard to patents, exclusivity and possible commercial developments. EJL was, in fact, quite familiar with such procedures. In northern France, for instance, they had gone to the extent of purchasing selected flyash dumps from the power authority, at which they set up sophisticated plants to produce premixed subbase and base material; not only for their own contracts, but also for contracts being built by rival contractors. It is also of interest to note that, in the case of Ash Resources, Eskom itself it is also of interest to note that, in the case of Ash Resources, Eskom itself and the major cement companies were the main shareholders. Those bodies must have played an important role in marketing the product successfully.

Although laboratory trials were carried out in both France and South Africa, insufficient attention was paid to co-ordination of the results. Enormous and unnecessary delays were incurred in despatching to France by air large samples of flyash, slag, even mine dump sand and local limes, all of which could satisfactorily have been tested at Wits or the CSIR. In fact, most of the laboratory workload should have been carried out in South Africa, using EJL colleagues as expert consultants.

Charles Digue, a flyash pioneer and enthusiast, later regretted cancellation of the street trial in Johannesburg. RL should, in fact, have offered, at their own cost, to build a few short stretches of street to Digue’s design. The cost would not have been enormous and could have proved the point, one way or the other, despite negative laboratory results. Digue himself was not one to discount laboratory results, but his flair and experience might have provided an eventual solution.

It is possible that the rejection of dump flyash because of its high silica content might have been premature. Ash Resources seem to have overcome that particular difficulty in their field. It is likely also that the slag project was prematurely terminated. Prof. Blight at Wits had been working on a mix comprising crushed slag, a stabilising agent and mine sand, which never obtained an opportunity for more extensive testing before closure of the project. The reasons for Slagment’s success, using Iscor slag, should have been taken into account. It seems that at the present time (2007), when innovation is being urged and supported at all levels, South Africa is not yet making great efforts towards beneficiation of wastes. Mining continues at a pace, coal-fired power stations continue to be built and the waste piles are mounting. If, however, methods and systems could be found to benefit some proportion of the wastes profitably, private enterprise might again be tempted to investigate the possibilities. Such an effort at innovation needs to be supported, supervised and assessed systematically, and the sponsor must accept reasonably high costs before reaping financial reward.

The waste materials programme never became a commercial proposition, although it produced a fair amount of interesting data at no great expense. It has to be classed as a failure, but it also represents, on reflection, a missed or ‘wasted’ opportunity.

2. METHOD-RELATED BILLS OF QUANTITIES: EARLY 1970s

In a paper entitled Generals and Generalship, Lord Wavell, before he became famous as head of the Eighth Army and Viceroy of India, had this to say about the matter of administration: “Unfortunately, in most military textbooks strategy and tactics are emphasized at the expense of the administrative factors. For instance, there are 10 military students who can tell you how Blenheim was won for one who has any knowledge at all of the administrative preparations that made the march to Blenheim [in 1704] possible. There were months of administrative planning to make Allenby’s manoeuvre at the third battle of Gaza [in World War I, 1914–1918] practicable. Again, Marlborough’s most admired stratagem, the forcing of the Ne Plus Ultra lines in 1711, was one that a child could have thought of but that probably no other general could have executed ... I should like you to always bear in mind when you study military history or military events the importance of this administrative factor, because it is where most critics and many generals go wrong.”

There is an analogy here with civil engineering, notwithstanding the derivation of the profession’s name. When the time comes for entering the civil engineering ‘battlefield’, one finds, despite technical excellence in their respective fields, that participants in the civil engineering process have a tendency to neglect administrative instruments and factors. One of those instruments is a document known as the bill (or schedule) of quantities (BOQ), which plays a vital role, in the office and the field, in the fortunes of all participants: employer, engineer and contractor.

This article describes and discusses certain fundamental innovations that were introduced into the standard BOQ which, at that time, had retained its basic format for a long length of time – in fact ever since the end of the 19th century. It is only in recent years that changes have been effected to it in order to meet the demands of a profession and industry that has had to adapt to the rapid technological advances of the modern era. This article sets down the history of how those changes came about.

The movement towards change

In South Africa, the switch from departmental construction (force account) to construction-by-contract had gathered pace and momentum by the early 1970s, but had left problems in its wake in the form of numerous claims, disputes and cost overruns. This unfortunate development threatened not only the standing and retention of the burgeoning industry, but also the relationship between its private sector and its employers, some of whom in any event had not been over-enthusiastic about the gathering strength and influence of consulting engineers and contractors.

Interestingly and co-incidentally, the British construction industry had been undergoing similar problems, especially in relation to massive claims and disputes, with the result that the research body CIRIA (Construction Industry Research and Information Association) was commissioned to look into the matter. In due course, when CIRIA published its findings in the proceedings of ICE (Institution of Civil Engineers), it was realised that its recommendations, by virtue of similar construction systems in the two countries, had direct relevance to the South African problem.

According to Dr Martin Barnes, author of the ICE paper, BOQs then in operation constituted nothing more than ‘shopping lists’, their format probably...
having been derived from the building industry where quantity surveyors tended to provide for a multitude of pay items, whatever their value in relation to the total contract. That type of BOQ made it easy for estimators simply to price the items and thereby avoid having to conduct a proper study of the drawings. Quantity surveyors had done the hard work for them. Civil engineering contracts however, as Dr Barnes pointed out, need somewhat more study in order for estimators to submit realistic rates and prices.

The paper also pointed out, in an analysis of typical bridge contracts, that about 80 to 90% of pay items contributed in the region of only about 5% to the total cost of the structures, and that such a plethora of items could easily, and without risk, be priced and covered by a single lump sum on the basis of a proper study of the drawings and specifications. As a result, estimators could spend more time in studying and pricing the physical and cost aspects of the principal elements of the proposed work.

The paper also made a distinction between quantity-related, method-related and time-related pay items. The new BOQ in fact featured a greater-than-normal number of lump-sum items for special activities such as setting up crushing plants or batching plants or ventilation facilities for tunnels – reimbursement for which, in standard BOQs, could be recovered only in much later payment of quantity-based items.

Furthermore, a more logical and comprehensive set of items was inserted under the P&G (Preliminary and General) heading: establishment of camps; movement of plant and equipment to and from site; overheads and running expenses generally. In such cases, a payment distinction was clearly made between once-only lump-sum items (e.g. setting up camp and workshops) and items that incurred monthly running costs (e.g. maintenance of camp and workshops).

The modifications suggested by Dr Barnes became known as the method-related bill of quantity and, in essence, its basic principles were: (i) reimbursing contractors in a logical fashion, through the BOQ, for costs as they arose in the field so as to improve their cash flow; (ii) producing a BOQ that would adapt to the contractor’s proposed method of managing the contract; and (iii) improving the employer’s understanding of how the contractor intended to set about the work.

In terms of the usual conditions of contract, however, estimators are at liberty to take risks, for instance by: (i) pricing lump-sum items at zero and allocating such costs to quantity-related items in the hopes of quantity increases – which are not uncommon in practice; or (ii) being free to over-price (load) their lump-sum rates in order to obtain early cash flow. A method-related BOQ did not possess the authority to eliminate those opportunities for those who wished to take such risks, but it would highlight companies that chose to gamble and put themselves at risk of losing the award by virtue of having submitted unbalanced bids. The method, however, protected the employer by virtually compelling estimators to expose their proposed modus operandi and thus reduced the chances of appointing a contractor who chose to gamble or might be permanently or temporarily short of cash.

The civil engineering community in South Africa quickly realised the merits of the method-related BOQ and, through the then Construction Division of SAICE (South African Institution of Civil Engineering), arranged for Martin Barnes himself to introduce the method to the country through a series of lectures and seminars in all major centres. The entire civil engineering community realised at the time that the method might offer a good chance not only of reducing the number of claims and disputes, but also of instituting a more straightforward style of pricing and payment. To use a standard cliché, method-related BOQ was welcomed because ‘its time had come’.

Method-related BOQs encouraged balanced tendering and tendencies towards risk-taking, in that way probably reducing the incidence of wrangles on site, which bore possibilities of ending in expensive and long-term formal disputes.

Introduction of the method was able to be brought about by simple administrative procedures, required no special legislation and incurred few, if any, extra expense.

Prospective innovations are often viewed with suspicion because they are not sufficiently studied or understood, but in this case all experienced participants readily grasped the advantages of the proposals.

The fact that ICE in London had helped promote the system and that Dr Barnes himself had come to introduce the system into South Africa certainly expedited acceptance and implementation. The Construction Division of SAICE (well stocked by contractors) had initiated and organised the Barnes visit – the cynical might say because of enlightened self-interest – but managed to prove the value of propagating any innovative concept through a committed and determined project champion.

**Discussion and comment**

Innovators frequently complain about slow reaction to their ideas and proposals. The method-related BOQ is an exception and a few reasons have been advanced for its successful reception.

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IN BRIEF

WORLD’S LARGEST FOAMED CONCRETE PROJECT TO SAVE RARE BAT SPECIES

AROUND 600,000 CUBIC metres of foamed concrete are being pumped into an old mine in the UK to preserve a major bat hibernation site. The village of Combe Down near Bath is now the site of what is thought to be the world’s largest single use of foamed concrete, with the estimated final volume approaching 600,000 cubic metres and due for completion by December 2009.

The Combe Down Stone Mines site – where the Greater Horseshoe Bat is found – is one of the 20 top bat hibernation sites in Europe and seventh best in Britain. However, the irregularity as traffic vibration and climatic conditions. This weakness has been exacerbated by factors such as little as one metre in some places.

After extensive trials and testing of suitable infill materials, including sand, stone and pulverised fuel ash, a lightweight (600 kg/m³) foamed concrete was chosen as suitable fill material, fulfilling the requirements of the client, the engineers and the contractor. Two of the bigger factors behind choosing foamed concrete was its ability to be made very light-weight, and be pumped over 1,000 metres into the mine. Another factor was the required rate of production: at peak production foamed concrete would be required at rates of over 200 cubic metres per hour.

For the design and supply of foamed concrete equipment and the extremely specialist foaming chemicals to achieve the type of performance and accuracy the project demanded, the contractor, Hydrock Contracting, turned to foamed concrete specialists, Propump Engineering. A modified Steelfields Major 2000 concrete plant, fitted with a 2,000 litre planetary mixer, 260 tonnes of cement storage and 60 tonnes sand storage bins – with a further 100 tonnes auxiliary storage – is used to supply the base materials, which after mixing are sent to a 6,000 litre holding tank for constant agitation.

From this tank, the base materials are drawn off by up to six large output grout pumps which feed the base materials a distance of up to 1,000 metres into the mine. The foam added to the base mix is manufactured in the mine by specially designed, custom-built mobile foam generating systems that produce dry type foam at variable rates between 100 to 1,000 litres per minute. Once the foam is produced, it is pumped up to 100 metres through 50 mm lines and then injected into the base material grout line via in-line mixing chambers, which continuously blend the foam and base materials together.

The resultant foamed concrete can then be pumped directly to the mine area requiring stabilisation.

The basic ‘isolate and infill’ method continues to date, with the last of the high hazard areas finished early 2006. Since this time both Hydrock Contracting and Propump Engineering have continued on site, under a separate contract, completing further infill works until March 2007 when the main scheme section of the works were awarded. This will see a further 300,000 cubic metres of foamed concrete complete the stabilisation of the Combe Down mine workings.

MAPONYA MALL

2008 STEEL AWARDS WINNER

At the 2008 Steel Awards function, hosted by the Southern African Institute of Steel Construction (SAISC) at the Vodadome in Midrand on 4 September, the Maponya Mall walked away with the overall winner’s award, to the applause of a record number of 750 guests.

This, the first up-market ‘mega’ shopping mall in Soweto, was built on the 21 ha property of prominent Sowetan businessman, Richard Maponya, who said the award was “a dream come true.”

The judges remarked that over the last few years, they have had a number of shopping centre entries, but few of them had the ‘wow factor’ that excited the panel enough to win many awards, let alone the ‘overall winner’ award.

According to the brief, the design needed to create a sense of community and this has been achieved by the large, naturally lit piazza that dominates the planning. Shoppers are first struck by the light and airy atmosphere in the mall and by the fact that the professional team has created a truly African feel.

“This is definitely not another one of those mortar-enclosed prisons we call the local shopping mall,” said the judges. “The futuristic water features in the front, the statues of the elephants and the fact that some of the shops and banks open out onto the parking area make a significant difference.”

The judges commented on the sheer size of the project, and the fact that no less than four steelwork fabricators were involved in making the structure happen in double-quick time. “The project makes truly excellent use of tubular steel, and is highly deserving of the 2008 Tubular category award, as well as the overall winner award,” said the judges.

What makes this achievement even more remarkable, is that the Institute had received 60% more entries this year than in any previous year. According to SAISC executive director, Dr Hennie de Clerq, the overall quality of the entries indi-
cated an extremely vibrant, healthy and creative steel construction industry in South Africa.

SOLVING SURVEY CHALLENGES AT GREEN POINT STADIUM WITH THE LEICA TOTAL STATION

SEVERAL STADIUMS IN South Africa are currently under construction in preparation for the 2010 FIFA World Cup. One of the largest projects, Cape Town's Green Point Stadium, will have a capacity of 68 000 spectators. The complex design of this stadium includes a steel cable tensioned glazed roof which will reach 55 m at its highest point.

John Trangos, Chief Surveyor for Murray and Roberts, says that the team was faced with some unique survey challenges, particularly those relating to the correct positioning of the raking pylons. The outside perimeter of the stadium has been designed to accommodate 74 raking pylons of various heights from 34 to 54 metres high. The pylons will support the roof and the overall effect will be a wave-like configuration. A perimeter compression ring and an internal cable tension ring form the basis of the roof which will rest on the raking pylons via the girder intersections on the underside of the compression ring.

The pylons each measure 3 m long x 800 mm wide and their upward and outward slant at 17.5 degrees has been particularly challenging. Trangos explains that the construction of the pylons is being carried out in 3.8 metre lifts necessitating approximately 12 lifts per pylon. The survey team has to position the formwork for each lift. Due to the weight of the roof, the accuracy of these columns needs to be perfect with very small tolerances. Maintaining integrity of control was difficult because of the acute upward angles. This would have necessitated working from quite a few different stations around the stadium.

After discussions with Leica, Murray and Roberts decided to erect a 16.5 metre high x 2 m diameter reinforced steel and concrete beacon, right in the centre of the stadium and then affixed a Leica 1200 robotic Total Station (TCRP 1201+R1000) to the top of the pillar.

Trangos says that they were fortunate in that the geometry of the stadium was such that it enabled a full view of the columns from the centre of the stadium. “This immediately gave us several advantages. The fully automatic Leica Total Station is controlled from our ground station via radio link so it can be left at the top of the pylon for any period of time. This was ideal as we could take all the necessary measurements of the raking pylons from one position. This also freed us up to do other survey work inside the stadium. We will also be able to utilise the Total Station from its position on top of the pillar when we position the steel segments on the roof.”

The Leica TPS Total Stations are packed with outstanding features and are built for speed, accuracy, ease of use and reliability.

MAPELASTIC SEALS CLARIFIER TANKS AT GROOTVLEI POWER STATION

FOUR AND A HALF TONS of Mapelastic Smart, a versatile waterproofing agent manufactured by Mapei, have been used to waterproof and rehabilitate two clarifier tanks at Grootvlei Power Station.

First commissioned in the late 1960s and then shut down in the early 1990s due to an over-supply situation, the power station is...
Mapeband TPE was used to seal the exposed into the grooves, after which 17 cm wide and contraction. Backing cord was inserted into the concrete floor to allow for expansion to three cm wide and five cm deep were cut and filling them with fresh concrete. drilling and removing the damaged sections had to be repaired. This was achieved by drilling and removing the damaged sections and filling them with fresh concrete.

Before the Mapelastic could be applied those sections of the floors where the erosion had penetrated into the sub-base concrete had to be repaired. This was achieved by drilling and removing the damaged sections and filling them with fresh concrete. Once the concrete had set, grooves two to three cm wide and five cm deep were cut into the concrete floor to allow for expansion and contraction. Backing cord was inserted into the grooves, after which 17 cm wide Mapeband TPE was used to seal the exposed grooves. Two coats of Mapelastic Smart were then applied to the floors and the walls. The first coat was applied horizontally by brush and the second coating was applied by roller using vertical strokes to create a better bond. Once the Mapelastic had dried, Mapeband TPE was applied to the joint between the walls and the floors.

Chris van Jaarsveldt, contracts director of Karrena Africa, says that both Mapelastic Smart and Mapeband TPE were very easy to work with. “Mapelastic Smart proved very easy to mix and apply and the finished product looks really good. I will certainly recommend it for use on similar projects at other power stations.”

Mapelastic is a cementitious membrane which, thanks to a high synthetic resin content, retains flexibility and water resistance up to pressures of 3 atm. According to Aucamp, it has excellent adhesion and elasticity properties which ensure long-term stability. Besides waterproofing, Mapelastic Smart shields concrete structures from the aggressive action of carbon dioxide, as well as protecting steel reinforcing in concrete from the salt in sea water. Moreover, its high elasticity and extendibility mean that structures which develop cracks as wide as 2.8 mm will be protected.

Mapelastic is a versatile and water-proofing material which is suitable for a wide range of applications from waterproofing large infrastructural projects such as concrete dams, canals, reservoirs, piers, bridges and water towers, to the protection of domestic installations such as swimming pools, baths and showers. Proven for over 17 years in waterproofing, and protecting more than 60 million square metres of concrete surfacing, it is specified by professionals all over the world.

Mapelastic Smart was supplied to the main contractor, Karrena Africa, by local Mapei agents, Engineered Concrete Systems (ECS). In addition, 330 metres of Mapeband TPE, used to seal the joints between the walls and the floors, were also supplied by ECS.

ECS product manager, Pieter Aucamp, says the clarifiers have been empty for more than a decade and their exposure to the elements and temperature extremes has resulted in the cracking and erosion of the walls and floors.

The clarifier tanks at Grootvlei Power Station which was waterproofed using four and a half tons of Mapelastic Smart.

RESEARCH FELLOWSHIP MARKS C&CI’s 70th ANNIVERSARY

THE CEMENT & CONCRETE INSTITUTE (C&CI) will award a Sustainable Concrete Research Fellowship to celebrate 70 years of operations in South Africa.

John Sheath, marketing manager of C&CI, who announced the new Research Fellowship at a function in Midrand recently.
ably South Africans) would have to hold at least an MSc in a relevant field and have a background in civil engineering, concrete materials science and/or engineering. If not in possession of a PhD, the applicant will be expected to submit the necessary dissertation for a PhD within the course of the Fellowship.

Applications for the Fellowship close on 1 November this year.

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SIKA’S ROBUST ADMIXTURES SECURE THE GAUTRAIN PROJECT

South Africa’s Gautrain Project is currently the biggest rail project under construction in the world. Sika is proud to have been selected as one of the key suppliers of construction materials to various facets of this development. Following the stringent testing of numerous concrete repair products, Sika’s high performance concrete products were approved for use in pre-cast concrete fabrication, by the Bombela Consortium, which heads up this R25 billion venture.

The Gautrain project houses the largest pre-cast yard in Africa and Sika South Africa has secured the contract to supply Sika Viscocrete-10 to the yard for the fabrication of bridge segments and bridge beams. For the production of these segments, a 90 minute slump life and a 180 mm slump was required, which the Viscocrete-10 easily provided. A dosage of 0,3% of Viscocrete-10 was used in the fabrication of the concrete and it was found that the Viscocrete-10 was less temperamental than the competitors’ products when faced with varying grades of cement.

Since its worldwide introduction, Sika ViscoCrete technology has become widely used for normal workability concrete, high early strength requirements as well as for self-compacting concrete. The technology was developed in the mid 90s and perfected in the early 2000s, resulting in the highest performance concrete admixtures based on polycarboxylates. The effect of this technology is much more powerful than conventional high range water reducers, which are based on melamine or naphthalene polymers. A vastly improved and controlled workability is now possible with lower dosages. An upshot of high early strength development with Sika ViscoCrete technology is extremely economical stripping times for pre-cast and in situ concrete ensuring that fast-track, durable concrete with high density, high strength and reduced permeability is achieved.

This faster turnaround of formwork results in higher output, reduction of cement content or the use of more economic cementitious materials, reduction of energy consumption, improved surfaces and appearance, earlier achievement of release strength which enables earlier handling and transportation of pre-cast elements, and excellent workability at low water/cement ratios allowing for production of ultra-high strength concrete elements.

The Gautrain pre-cast yard fabricates an average of between 35 and 45 bridge segments and beams per week, which is not huge
in the great scheme of things considering that a total of 3 402 is needed to make the 8,5 km of viaducts for the Gautrain. The consumption of Sika Viscocrete-10 to date in the production of these segments has been approximately 46 000 ℓ and a further 35 000 ℓ will be used up until the end of 2008.

Sika Viscocrete-10 is a third generation superplasticiser for concrete and mortar and is especially suitable for concrete mixes with extended transportation times and extended workability requirements, ultra high water reduction and excellent flow characteristics. This powerful superplasticiser acts through several mechanisms: through surface adsorption and sterical effects separating the cementitious binder particles, the following properties are achieved:

- high water reduction, resulting in high density, high strength and reduced permeability
- excellent plasticising effect, resulting in improved flow, placing and compaction characteristics
- reduced shrinkage during curing and reduced creep when hardened

Visocrete-10 does not contain chlorides or any other ingredients which promote the corrosion of steel, it is therefore suitable for use in reinforced and pre-stressed concrete structures. The Gautrain bridge segments are bonded with Sikadur-31SBA S-02, an epoxy adhesive which conforms to the FIP standards as required by the Bombela Consortium. The total amount of Sikadur-31 SBA S-02 used to date is approximately 6 700 ℓ with a forecast of 65 000 ℓ. The Sikadur-31 SBA S-02 is applied between the segments by hand at a thickness of ± 3 mm and then after stressing a bond line of ± 0,5 mm is achieved. The consumption per joint is 35 ℓ.

Sikadur-31 CF was used to glue the bearing pads onto which the concrete beams are placed. This two-part, thixotropic adhesive...
epoxy adhesive and repair mortar can be applied to a range of component surfaces such as concrete elements; hard natural stone; ceramics and fibre cement; mortar, bricks and masonry; steel, iron and aluminium; wood; polyester and epoxy; and glass. It is particularly suitable for use on the Gautrain project as it adheres to dry and damp concrete surfaces, is extremely flexible, hardens without shrinkage, has a high strength adhesive as well as a high initial and ultimate mechanical strength and is impermeable to liquids and water vapour.

Sika’s valuable contribution of high performance construction materials and world class engineering skills to the Gautrain project certainly bodes well for its long-term resilience and reliability.

INFO
www.sika.co.za

TRENCHLESS TECHNOLOGY AWARD

Vela VKE Consulting Engineers earlier this year won the Southern African Society for Trenchless Technology (SASTT) award for excellence, together with Trenchless Technologies (the contractor) and Johannesburg Water (the client). The award was presented at the SASTT’s AGM, in recognition of the work done on the Klipspruit Basin sewer upgrades in Johannesburg.

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Sam Efrat (Trenchless Technologies) sam@trenchless.co.za

The project works comprised the rehabilitation and upgrading of 2,3 km of sewer pipes with diameters greater than 150 mm, primarily by means of trenchless technology, due to the location of the pipes. The works were implemented in three locations within the basin Joubert Park, Oriental Plaza, and New Centre in Rosettenville.

Preliminary scoping of the works was based on previously recorded closed-circuit television (CCTV) camera survey footage, but the need for a pre-implementation CCTV camera survey was identified and specified as part of the contractor’s scope of work. The CCTV camera surveys assisted in identifying the following general problems: corroded pipes, water infiltration, cracked pipes, broken pipes and root intrusion.

The locality of the works was the primary reason for the application of trenchless technology. At the Oriental Plaza the upgraded sewers were located within the Plaza parking area and the surrounding streets. As the Plaza receives approximately 28 000 visitors per day, minimal disruption was crucial. In Rosettenville the rehabilitated sewer was located in a major arterial road and crossed underneath a railway line, requiring minimal disruption.

The project was executed over an eight month construction period achieving substantial economic, social and environmental benefits.

The contractor, Trenchless Technologies, had used their TERRA-JET 1712 B machine on this project. This HDD (Horizontal Directional Drilling) machine had been produced in 1994, but in spite of its age was (and still is) in daily operation. Subsequent to the award-winning project, Trenchless Technologies took possession of a TERRA-JET 7520 D, which they promptly nicknamed ‘Big-Boy’.

According to co-owner of Trenchless Technologies, Sam Efrat, ‘Big-Boy’ is an impressive piece of precision engineering with many innovative and unique processes. “It will enable us to offer our clients longer bores and larger pipe diameters, even in hard ground. The TERRA-JET 7520 D can undertake bores of up to 400 m length which can be back-reamed up to 800 mm. Additionally it is equipped with rock drilling tools, which will allow us to offer guided rock drilling.”

The benefits of using trenchless technology include reduced excavation costs, less long-term damage to road surfaces and minimal disruption to vehicle and pedestrian traffic. There is also limited environmental impact and a time-saving factor, as no full environmental impact assessment is required. Trenchless methods reduce service congestion in developed cities and leave more space available for other services development.
CSIR engineering geologist wins esteemed JD Roberts Award

Dr Phil Paige-Green, an acclaimed engineering geologist at the CSIR (Council for Scientific and Industrial Research), has been named winner of the 2008 JD Roberts Award. The award was handed to him at a function held in Pretoria on 22 July 2008. He received the award for outstanding research and innovation, with an international flavour, in the transport infrastructure field. His research has resulted in the application of products, improved materials usage and specifications for sustainable road construction, which have had great social impact.

Dr Paige-Greene, a Fellow at CSIR Built Environment, is currently working on a project – worth more than R5 million – to develop a cost-effective way of using renewable sources, specifically waste products, in road binding materials. Given oil shortages, the environmental effects of fossil fuel usage and global climate change, various alternative binders needed to be investigated and developed by the CSIR. Consequently, a prototype binder based primarily on materials currently considered to be waste products has been developed. This material is being evaluated and improved to develop the necessary properties for use as a road binder.

Dr Paige-Greene has led various projects in 14 countries in Africa, including Botswana, Ethiopia, Ghana, Malawi and Uganda. His research has helped some countries to upgrade their road design manuals and he has also assisted them with training guidelines and conducted road improvement investigations and technical audits.

Breakthroughs by Dr Paige-Green include his research on tillites (a type of rock), which saw him becoming a world authority on the topic. His later research centred on materials for the construction of unsealed roads, culminating in the development of innovative specifications, deterioration models and construction requirements. These have been implemented internationally. His work on unsealed roads evolved into the upgrading of such roads to low-cost sealed ones, for which he again received international recognition.

Dr Paige-Green has won a number of awards for best papers at conferences and currently serves as the Vice-President (Africa) of the International Association of Engineering Geology. He has published more than 90 papers, and contributed two chapters to Engineering Geology of South Africa, Vol. 3, the authoritative work on the engineering properties of South African natural materials. He is also the author and co-author of more than 300 contract, research and unpublished CSIR internal reports.
News from the South African Academy of Engineering

ABOUT THE SAAE
Academies of Engineering worldwide are playing an increasingly supportive and consultative role, working in concert with governments, business, academia and other engineering institutions in times where the competitiveness of nations is technology driven. In most developed and developing nations, Academies of Engineering (which include all disciplines of engineering) are deemed to be so important that they report directly to the office of the Head of State.

As South Africa braces itself to face the biggest challenge in its history, the South African Academy of Engineering (SAAE) is steadfast in its belief that it is well poised to meet its stated objective in serving the best interests of the country (and not the interests of its members). Time, however, is not on our side. The challenges facing the country in terms of infrastructure and economic growth in the face of a critical skills shortage are such that the Academy needs to be in a position to harness its resources to support the AsgiSA (Accelerated and shared growth initiative for South Africa).

To achieve these goals, two critical elements need to be in place: the full support of government in terms of speeding up the process in getting the
new SAAE Act in place, and the support of the business and engineering community. The latter is in place, and key business and engineering leaders, who are distinguished technology leaders as well, are already (or will be approached to become) Fellows of the Academy. Now government needs to play its role in accelerating the legislative process.

In summary, the value added by the SAAE comprises largely the following:

- It is the only voluntary professional engineering advisory body representative of all disciplines in SA.
- It compliments the statutory functions of ECSA (Engineering Council of South Africa), ASSAf (Academy of Science of South Africa), NRF (National Research Foundation) and NACI (National Advisory Council on Innovation) as well as the roles of the many single-discipline Engineering Institutions in South Africa.
- It networks with Government, universities, industry, ASSAf and Academies of Technological Sciences and Engineering around the world.
- It serves as a motivating factor for young and potential engineers.

**NEW EXECUTIVE COMMITTEE AND OFFICE BEARERS FOR 2008 – 2010**

At the AGM on 28 May 2008 the following Fellows were elected to serve on the Executive Committee:
- Dr Con Fauconnier, Retired Chief Executive, Exxaro Resources Ltd
- Mr Trueman Goba, Executive Chairman, Goba Consulting Engineers & Project Managers
- Prof Fred Hugo, Emeritus Professor and Director ITT, Dept Civil Engineering, University of Stellenbosch
- Dr Bingle Kruger, Retired CEO, BKS
- Mr Braam le Roux, Retired CEO, Spoornet
- Prof Roy Marcus, President, Engineering Association
- Prof Tshilidzi Marwala, Carl and Emily Fuchs Chair of Systems and Control Engineering, University of the Witwatersrand
- Mr Bob Pullen, Past President, ECSA
- Prof Roelf Sandenbergh, Dean, Faculty of Engineering, Built Environment and Information Technology, University of Pretoria
- Dr Mike Shand, Director, Ninham Shand

**Office Bearers:**

At the first Executive Committee meeting in August the following Fellows were elected as Office Bearers:

- President Mr Bob Pullen
- Vice-Presidents Prof Roelf Sandenbergh, Dr Con Fauconnier
- Treasurer Mr Braam le Roux

**NEW FELLOWS**

At the AGM the following new Fellows were also elected:
- Salim Amod, Managing Director, Development and Engineering Consultants (Pty) Ltd
- Francois Anderson, Chief Radar & EW System Engineer, CSIR Fellow at CSIR DPSS
- Prof Andries Burger, Professor and Departmental Chairman, Process Engineering, University of Stellenbosch
- Stefan Hrabár, Director, Merlim (Pty) Ltd
- Prof Beatrys Lacquet, Dean, Faculty of Engineering and the Built Environment, University of the Witwatersrand
- Pierre Lombard, Railway Engineering Consultant
- Willem Louw, Managing Director, Sasol Technology
- Prof Alan Nurick, Head, Department of Mechanical Engineering Science, University of Johannesburg
- Prof Gerald Nurick, Professor, Department of Mechanical Engineering, University of Cape Town
- Dr Gustav Rohde, CEO, Africon
- Prof Alphose Zingoni, Professor of Structural Engineering, University of Cape Town

**CONGRATULATIONS TO FELLOWS LAWLESS AND HUGO**

SAAE is very proud of Fellows Allyson Lawless and Fred Hugo who received awards in categories A and F respectively for their outstanding contributions towards scientific, engineering and technological development at the 10th National Science and Technology Forum (NSTF) Awards Gala Dinner on 27 May 2008.
THE SAICE PROJECT Management Division has amongst its other goals and objectives taken over the duties of the Construction Division. One of these duties was the presentation of the Basil Read Award, usually performed in conjunction with the Sandy Jamieson Memorial Lecture. However, the demise of the Construction Division some years ago resulted in the failure to arrange the Memorial Lecture and to make the Award. The Project Management Division is considering whether this omission should be corrected.

The Construction Division started the Basil Read Awards in 1976 in honour of Mr Basil Read, to provide for the recognition of individuals who had made a significant impact and contribution to the civil engineering construction industry.

Mr Read was a legend in his time in the construction industry. He graduated from the University of Cape Town in 1940 and enlisted with the South African Engineering Corps where he served in Kenya, Ethiopia, North Africa and Italy. After the war he joined Walton Grey and at the age of 32 was made Managing Director. In 1952 he formed Basil Read (Pty) Ltd. The company continued to flourish under his directorship, eventually merging to form Group 5. Shortly before his untimely passing he was involved in the staff buy-out to form the new Basil Read (Pty) Ltd.

Mr Read was very involved in the civil engineering profession and was the instigator and the first chairman of the SAICE Construction Division. He was also very active in SAFCEC (SA Federation of Civil Engineering Contractors) and served on their Executive Committee, eventually becoming Vice-President. He was also a founder member of the Civil Engineering Industry Training Board and served as chairman on the training committee for the Transvaal and Orange Free State. Mr Read was an extremely generous person and personally financed Mr Martin Barnes’ lecture tour of South Africa to promote the method-related Bill of Quantities which is the basis of the current schedule of quantities in use today.

The conditions for the Basil Read Award were/are as follows:

1. The Basil Read Award consists of a Gold Medal and, in addition, up to two Bronze Medals which may be presented annually to a member of the Institution who is employed in or associated with civil engineering construction and who, in the opinion of the South African Institution of Civil Engineering (SAICE) has made an outstanding contribution or rendered significant service to civil engineering construction, normally within the previous two years.

2. Nominations and motivations are to be invited annually from individual members and/or from SAICE Branches and Divisions, and are to be submitted in the first instance to the SAICE Construction (Project Management) Division which will pass its recommendation on to the SAICE Executive Board for approval.

3. The Construction (Project Management) Division will take into account the achievement of candidates in one or more of the following fields when considering its recommendations:

   Direct control of an engineering construction unit which achieves an exceptionally high production coupled with a concomitant reduction in cost.

   Development of engineering techniques which have made a major contribution to the efficiency of a significant part of the construction process, or engineering or management techniques
CESA also a winner at SAACE’s awards evening

The South African Association of Consulting Engineers (SAICE), at their prestigious 2008 Engineering Excellence Awards function, held on 6 August at the Sandton Sun, not only rewarded engineering excellence, but also launched its new identity, Consulting Engineers South Africa (CESA).

As CESA, according to president Felix Fongoqa, the Association has repositioned itself more prominently as the ‘Voice of Consulting Engineering’ in South Africa to better address the challenges and opportunities of the future, and to continue adding value and enhancing the business interests of consulting engineering firms.

SAICE’s heartiest congratulations go to the new CESA and to all the winners in the various categories of engineering excellence.

Category winners at the 2008 CESA Engineering Excellence Awards function held at the Sandton Sun, Johannesburg

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<tr>
<th>YEAR</th>
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<td>1976</td>
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<td>1977</td>
<td>AG Davies</td>
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<td>1978</td>
<td>H McKay</td>
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<td>1980</td>
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The list of considerations is not exclusive and motivation for the Award need not be confined to these fields of endeavour.

In the event of no suitable candidate being proposed, the Construction (Project Management) Division may withhold its recommendations in any one year. Bronze medals may be awarded in a year in which no award for the Gold Medal is made.

The prestige of this award can be evaluated by perusing the list of previous awards up to 1994 (see table).

The Construction Division initiated the Memorial Lecture for Mr Jamieson who was one of the icons of the profession. Mr Jamieson graduated from the University of the Witwatersrand and spent his first three years working for the South African Railways and Harbours. Thereafter he joined Basil Read in 1956 and was appointed Chairman and Managing Director in 1974. Basil Read then formed part of the merger of several companies to form Group 5 Engineering and Mr Jamieson was made Chairman of this organisation in 1983.

Mr Jamieson was an active member of SAICE and served on both the Council and the then Executive Committee. He was also very involved with SAFCEC and served on several committees, as well as chairman of their Executive Committee. He represented SAFCEC on the Civil Advisory Council and the Client Liaison Committee, and in addition he was a member of the Civil Engineering Training Board and the S.A. Council for Professional Engineers.

In the light of the aforementioned, it was therefore quite appropriate that the Jamieson Memorial Lecture and the Basil Read Award should be created in honour of these legends of the industry and that they should be addressed at the same function.

The Project Management Division therefore invites comments about the appropriateness of the re-introduction of the Lecture and Awards bearing in mind the plethora of other awards that are currently available, none of which really cover the construction industry as a whole.

COMMENTS AND SUGGESTIONS

may be sent to Derek Burger at burgerd@VelaVKE for reference to the Project Management Division.

which will significantly reduce costs in the construction process.

- Overcoming extreme physical obstacles encountered in the execution of construction work.
- Solving unexpected and difficult problems encountered on a construction project, including imaginative and practical design solutions.
- Methods leading to significant simplification or improvement of construction organisation and planning.
- Contributions resulting in a significant improvement of the image of construction.

The list of considerations is not exclusive and motivation for the Award need not be confined to these fields of endeavour.

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COMMENTS AND SUGGESTIONS

may be sent to Derek Burger at burgerd@VelaVKE for reference to the Project Management Division.
ROAD TRAFFIC AND CARBON DIOXIDE

Against the background of reports issued by the United Nations Intergovernmental Panel on Climate Change (IPCC), the pollution of the environment remains a subject for discussion. Being a padmaker I am particularly interested in the figures relating to road traffic.

We have all at some time or other heard or read about tub-thumpers declaring that the carbon dioxide released from the exhaust pipes of the pernicious motor cars and trucks is threatening the world with flooding, drought and sunburn. But what are the facts? I am an engineer, and thus have a liking for figures!

It is estimated that 770 billion tonnes of CO₂ are released by natural processes every year. Of this figure human activity produces 26 billion tonnes, and road traffic is responsible for only 10% of this, 26 billion tonnes, one third of one percent of the total. Wow!

More figures: if the speed of traffic is increased from 10 kilometres per hour to 20 kilometres per hour, CO₂ emissions can be reduced by 36 percent; increase the traffic speed to 30 kilometres per hour and the reduction can be 46 percent. And so on. (World Highways, March 2000:34; July/August 1999:7)

So it seems to me that if we are really worried, after looking at that one third of one percent figure, about vehicles being responsible for causing the end of the world because they release carbon dioxide into the atmosphere, we should desirably react by providing roads adequate to ensure that there will be no standing or crawling queues of vehicles!

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ROAD ASSESSMENT

Tens of thousands of kilometres of our country’s paved roads are in a shocking state and deteriorating rapidly. The old adage ‘a stitch in time saves nine’ is as true for roads as it is for clothes. Indeed, it is particularly apt because my intuition tells me that the cost of repair will rise exponentially with the time of neglect. It is, therefore, urgent that the degree of deterioration be quantified, and the costs of repair and the consequences of neglect, both financial and logistical, brought pertinently to the attention of those who are responsible. The data needs to be publicised widely so that voters are made aware of the consequences that lack of action will have on their lives.

In a country such as ours, which is desperately short of technically trained people, the easy way out is to shrug our shoulders and say that this type of assessment can’t be done; we haven’t got the manpower. But I would suggest that we are more resourceful than that and would urge our academic engineers to come up with a method of assessment that can be done by an intelligent layman. It may not be entirely accurate but, if it could give results with a mean and even 80% confidence limits, this would be vastly better than doing nothing. In my ignorance, perhaps something like the following:

Grade A: Perfect, nothing needs to be done now, budget for resurfacing in ‘a’ years’ time at a cost of R b’ per kilometre.

Grade B: Occasional (< 1 per 50 metres) shallow (< 20 mm deep) potholes and/or mild crumbling of the surface. Cost of repair: R c’ per kilometre, rising by ‘d’% p.a. if nothing is done.

Grade C: Multiple and/or deep potholes and/or severe disintegration of the surface. Cost of repair R e’ per kilometre rising by ‘f’% p.a. if nothing is done. Time to when it will be necessary to re-do the road: ‘g’ years at a cost of R h’ per kilometre.

(I assume that costs, and the history of costs, are known and that this can be extrapolated into the future. I also assume that the emergence of potholes tells us something about the state of the underlying substrate, thus allowing for prognostication.)

This data could then easily be put onto a spreadsheet and total costs for an area calculated (with confidence limits as mentioned above).

Engineering would not be the only discipline to do something like this. The commonest causes of death in childhood (HIV/AIDS excepted) are diarrhoeal and respiratory infections. The paediatric community realised a long time ago that there were not enough doctors, let alone paediatricians, to assess all the patients with these conditions. They therefore trained nurses to recognise the symptoms and signs, how to treat the relatively minor cases, and when to refer the more serious ones. This was highly successful in terms of increased survival. One of the important tasks of all academics is to simplify difficult and complex problems for the benefit of the entire population.

SKILLS SHORTAGE

Further to a recent panel discussion on Praatsaam on RSG on the subject of the skills shortage in the civil engineering and allied industries I feel compelled to tell you my experience with the SACPCMP (South African Council for Project and Construction Management Professions).

Around July 2004, while working as R.E. on a project in the Northern Cape, I received application forms from the above body requesting various documents regarding academic qualifications, etc., and dissertations on two recent projects completed under my supervision, in order to achieve professional status as either Construction Manager, or Project Manager. I duly completed the formalities, and waited expectantly, because without accreditation by the SACPCMP I would not be allowed to continue working in my then capacity beyond a certain date.

When the deadline for compliance with the new regulations drew close I queried the outcome of my application only to be informed that they had ‘lost’ my documentation and would I please re-submit. A lengthy series of emails, faxes, telephone calls, including some scathing remarks by myself over a period of about six months resulted in them suddenly ‘finding’ my lost file, and then numerous dates

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for an interview were set and postponed ad nauseam. This process continued until the end of 2006 after which I came to the conclusion that government was not really interested in making use of the wealth of experience locked up in the older generation.

We are desperately short of skilled supervisors at every level of site work. There is a misconception that tertiary education equals skill. The truth of the matter is that the person with the higher education will understand the processes of the work better and can become skilled more easily and more quickly than the lesser educated. The problem is, however, that people want to be managers the moment they qualify, and the tragedy is that so often they are appointed to their level of incompetence, and never make the grade, and in the process the work under their care is substandard.

During some six years of mentoring emerging contractors and engineering staff I only met one young newly qualified technician who was prepared to get his boots muddied, crawl into awkward places, do menial tasks, etc., and most importantly, he was teachable – he had the makings of an engineer of renown.

When I was a site agent my foremen and I never went home until we had done our daily costing and if necessary decided on action in the event of a loss-making operation. I was horrified to find that the past three contractors that I supervised as R.E. had no site costing system in place; it is surely one of the most basic and essential management tools for any site manager! Small wonder so many of these contracts finally cost far in excess of the tendered sum, as the authorities have to bail them out!

My own conclusion is that the decline of the industry in the latter 80s - early 90s, together with affirmative action which led to the departure of much of the skills core, with few or no new entrants, has resulted in the dilemma we find ourselves in. Churning out technicians and graduates is a long-term solution. For the short-term the only solution is to bring back the oldies, each one for what he can contribute.

A lot has been said on the subject, and a lot more can be said, but it is now time for action.

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<td>Peter Cousins</td>
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<td>3 – 4 November Gauteng 6 – 7 November Durban 10 – 11 November Cape Town</td>
<td>The 28th Annual Southern African Transport Conference (SATC 2009) Theme: Sustainable Transport</td>
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