WATTnow

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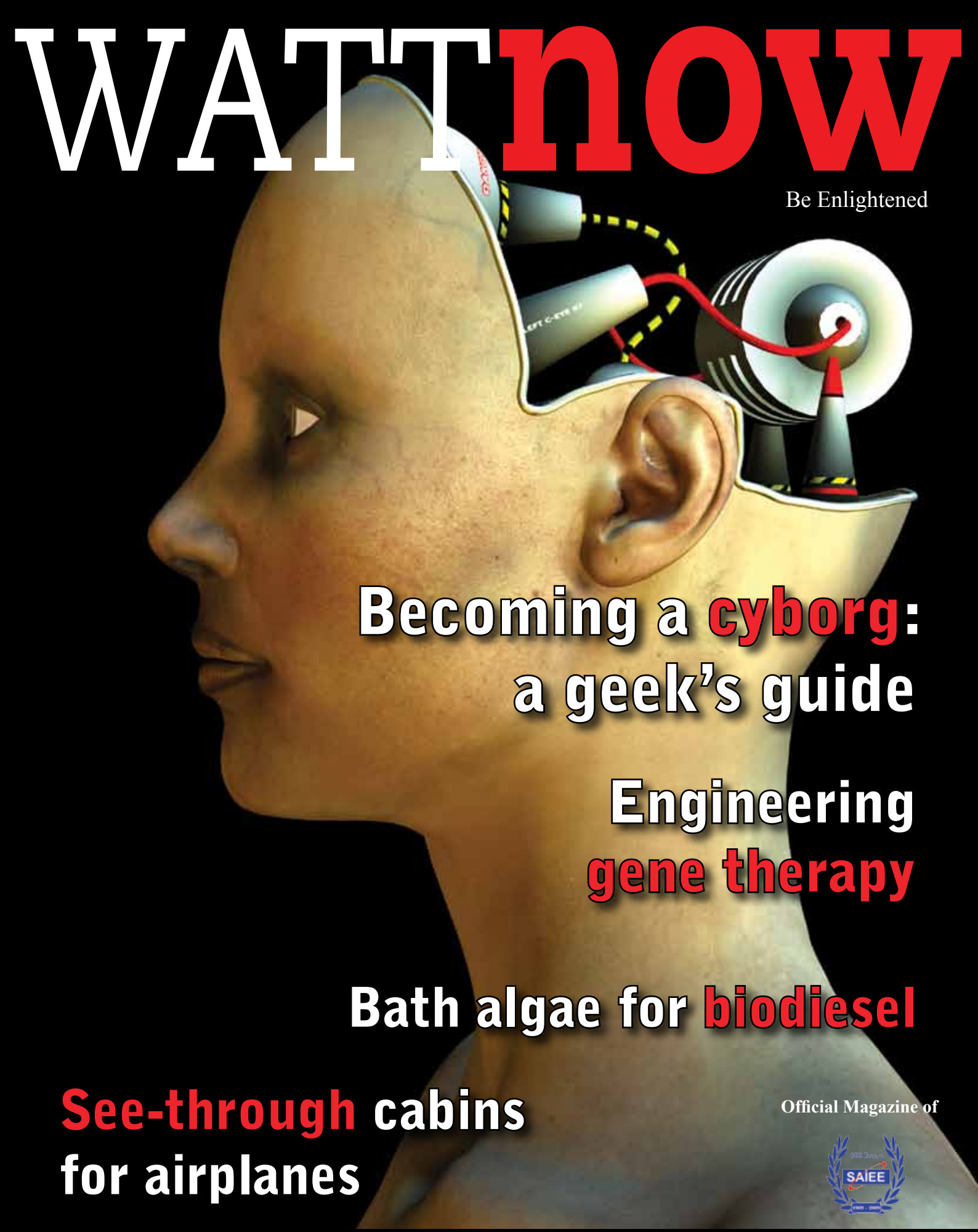

Becoming a cyborg: a geek's guide

Engineering gene therapy

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Official Magazine of

SAIEE

July 2011

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30 000 apprentices – it can be done

If the latest predictions from the business community are correct – and I have no reason to suspect they are not – then the skills shortages that are plaguing the country might soon be solved.

In terms of two recent accords, signed by members of the business community, the government and trade union leaders, at least 30 000 new apprentices will be recruited and given work while learning.

And that's where the gravest shortage of skills actually lies, for artisans are an essential part of the foundation of the engineering triangle.

The electrical engineering community has been rather tardy about providing apprenticeships for its own industry as have the building, construction and industrial sectors. There are a number of reasons for this, but predominantly the Sector Education and Training Authorities (SETAs) have failed to produce the kind of workers we need in this country.

In practice, the SETAs have wasted the vast sums of money they received over the years and have succeeded only in turning out workmen who are unproductive and under-equipped to do the job properly while business, on the other hand, wanted skilled, productive workers who could do a competent job with minimal supervision.

The twain never met. And our skills faded away as businesses abandoned or disregarded much of the SETA training and set up their own in-house training programmes instead.

With the latest accords, though, this might change quite radically. Let's leave aside arguments about additional taxation and poor basic education and focus instead on how the apprenticeship system could be of some meaningful benefit to the country as a whole.

Businesses throughout South Africa have proven – in years gone by – that apprenticeship training through indentureship provides a harvest of skilled artisans; and these are the people we need so badly right now.

To achieve their goals of getting 30 000 apprentices into training several things are required:

- First of all more money is needed but this can be found through the voluntary skills levy that has been set up. If it rises to between 4% and 8% of the payroll then the money is there for training. Wealthy companies can probably afford to pay these levies but those companies that are struggling might baulk at it. However, all companies must realise that the benefit of training is for the sector as a whole so I think that everybody should contribute something – no matter how small – to help pay for apprenticeships.
- Job opportunities are hard to come by for youngsters today and apprenticeship training offers an ideal format to get them off the streets and working productively. The key here is to get the unions to steer away from minimum wage demands, excessively generous conditions of service and wide-ranging benefits because the most important factor is to get people working and to give them skills. Without skills, they remain unemployed and unemployable. Hopefully the unions themselves will set aside their unrealistic demands and invest, alongside the companies, in the future of the country and not just the short-term rewards of employees.
- The third key factor is that each industry must set itself achievable goals for training and take a long-term view of these benefits. I would really like to see sectors such as the SAIEE taking the lead here and setting up, for instance, an industry-wide agreement for apprenticeship training and, through levy collections, using the money to pay part of the salary for each apprentice so that the financial pressures on individual companies are alleviated – albeit in a small way. After all, apprentices benefit the whole industry, not just the company they are working for.

If we can achieve these three factors, I think it just might be possible, in three years, to make a huge dent in the shortage of skills that is plaguing this country and hampering its sustainable economic growth.

But it will take co-operation from the youth, the unions and industry associations. If we can do it, then real, positive and sustainable economic growth might be the impetus that this country needs to turn it into Africa's true economic giant.

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WATT'S

WATT'S HAPPENING




5> WATT'S GOING ON?

Wind farms set to change the landscape; IDC to invest R102-billion in five years; Partnerships are essential for economic growth; 460 sewage works in critical state; Dreamliner jets into Tokyo; Electricity distribution nightmare for Eskom; Cape Town to get desalination plant?; Gaming worth R20-million to SA's economy.




INSTITUTE PAGES

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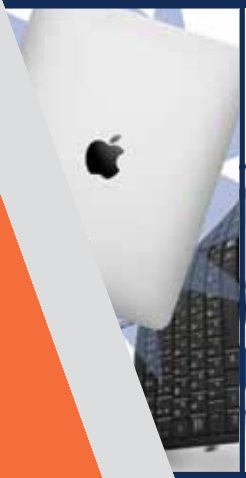

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Wind farms set to change the landscape

At least 88 wind farms are likely to be built in the Eastern and Western Cape provinces as government remains steadfast in its goal to increase the country's renewable energy resources.

So far 88 applications have been submitted for wind farms and of these 40 are in the Western Cape. If approved, there will be at least 2 800 wind turbines operating in the province, although the final number is likely to be even greater as the developers of five wind farms have not yet decided how many turbines they will erect.

The Eastern Cape region is also favoured by wind energy development companies and the Department of Environmental Affairs has received 31 applications for wind farms. Each developer must submit an environmental impact assessment with the application for a wind farm.

These wind farms will transform the landscape in both the Eastern and Western Cape as each turbine stands at a height of between 80m and 160m, equivalent to the height of a 30 storey building.

The sites for the wind farms have been chosen on the basis of the amount of wind in the region and for their proximity to the national grid so that electricity can be used by Eskom.

The Western Cape's West Coast region – which is notoriously gusty – includes sites at Darling, 60km north of Cape Town all the way up to Vredendal on the Olifants River, about 300km from the city. A cluster of 10 wind farms has been proposed for the Saldanha/Vredenburg district.

There are also applications pending for eight wind farms along the Garden Route with four of these at Swellendam, two near Mossel Bay and two in Bredasdorp. There are sites for five farms in the Overberg area, three in Caledon and two in the Karoo near Beaufort West and Laingsberg.

The smallest wind farm is at Albertinia where just six turbines will be erected, while the largest one is likely to be built at Middleton, near Caledon and will have 685 turbines. The farms planned for the Karoo are also large with 270 turbines proposed for the farm near Beaufort West and 400 turbines being built between Laingsburg and Sutherland in the Northern Cape.

Meanwhile, building work on a new 300MW wind farm in Kouga in the Eastern Cape is likely to start soon since Red Cap Kouga Wind Farm Development Company has been granted the necessary authority by the Department of Environmental Affairs to go ahead with the development. It will be built in three phases along a stretch of land on the south side of the N2 between St Francis Bay and the Tsitsikamma River. It will have 121 turbines when complete.

IDC to invest R102-billion in five years

The Industrial Development Corporation has confirmed that it will invest R102-billion over the next five years as part of its plan to provide economic stimulation to South Africa's ailing economy. Last year the IDC invested just R8,4-billion in new projects. According to chief executive, Geoffrey Qhena, the key to successfully making these investments lies in forming partnerships with various stakeholders and social partners that include businesses, co-funders, labour, government and civil society.

The R8,4-billion investment by the IDC during its 2011 financial year was the highest level of investment recorded by the organisation. He says the investment resulted in 19 650 permanent new jobs being created and an additional 11 650 part-time jobs being given to ancillary workers.

Qhena says that the combined impact of creating 31 300 jobs was substantial and a further 8 100 jobs will result through other activities that are linked to investments in the informal sector. It says that the investment per job was R270 000.

The IDC has remained profitable – despite its increased levels of investment – and recorded an annual profit of R2,7-billion during the period. It says that a strong performance from its equity accounted investments has contributed to this profit along with determined efforts by the organisation to contain costs.

He says that only R4,1-billion of a R6-billion fund has been allocated to assist distressed businesses over the past two years and that while he is disappointed with the lack of response to the funding offer, indications are that applications to the IDC are improving after the corporation conducted roadshows and public engagements with businesses.

He says that any investment made by the IDC must show that it is sustainable and that it will create jobs for South African workers.

Partnerships are essential for economic growth

Both the private and public sectors must strive to make South Africa an attractive environment for investment says Johan Greyling, Africa infrastructure and projects director at KPMG.

He says that South Africa is competing for investment funds with all the other countries of the world and as a result must ensure that it represents an attractive and sustainable destination for global investors.

He was addressing delegates at the recent Public Private Partnership (PPP) Summit held in Johannesburg. He says that while some liquidity has returned to the foreign investors, South Africa still has to compete vigorously with other countries who are just as eager to secure investments.

Lucy Chege, divisional executive at the Development Bank of Southern Africa told delegates that investors want clear and fair procurement systems for PPPs and that the South African government wants more and more companies involved as local partners in new developments.

According to Stanley Kamau, head of PPPs in the Kenyan National Treasury, the Kenyan government needs the private sector to help it fund the estimated $40-billion that it faces for infrastructure development.

He says that Kenya is aiming to achieve sustainable growth of 10% a year and in order to do so needs to dramatically improve its infrastructure as, without these improvements, it will not be able to sustain this target.

Kenya's debt to gross domestic product ratio is currently at about 48% and this makes it impossible for the country to achieve its infrastructure development needs without the direct involvement of private sector investors.

Apart from infrastructural needs, Kamau points out that there is no clear legal framework for PPPs in that country and there is also a poor level of awareness about the PPP initiatives the country wants to embark on. He blames a lack of government knowledge for this.

Meanwhile, Karen Breytenbach, a senior project adviser at the PPP unit within South Africa's National Treasury says that the government needs the support of private sector investors to get additional infrastructure projects off the ground and create the jobs that this country so badly needs.

She says that the government is determined to receive 'value for money' when it comes to negotiating new contracts with private sector organisations and emphasises that contract management and monitoring of these contracts is now an important part of government policy.

460 sewage works in critical state

Less than half of South Africa's sewage works are treating billions of litres of effluent effectively according to the latest Green Drop Report, which measures wastewater treatment plants in all nine provinces.

The Minister of Environmental Affairs, Edna Molewa, awarded Green Drop status to 40 plants around the country but warned that another 460 sewage works were in a critical state or delivering a very poor performance.

The report examined waste water treatment at 821 plants in 156 municipalities – the previous report examined just 444 in 98 council regions – and says this provides 100% coverage of the water works in South Africa. It does not examine water quality in other sectors such as prisons or those run and maintained by private operators.

According to the Green Drop report, many of the poorly-performing plants are located in South Africa's poorer provinces including the Eastern Cape, Free State, Northern Cape and Limpopo. The Western Cape is the top-performing province followed by KwaZulu-Natal and Gauteng. The report's findings imply that millions of litres of untreated or inadequately treated water are being illegally discharged into South African rivers and streams each day. The report describes the risk trend for 821 treatment plants as 'neutral to negative' and says that the 'critical risk' wastewater treatment plants had increased from 129 to 137. The number of 'high risk' plants had risen from 264 to 284.

It says that municipal wastewater treatment services varied from 'excellent' to 'unacceptable'. The national average for water treatment was 71% but this must be seen in the context of the fact that excellent provincial scores balance out the lower provincial performers.

South African sewage works treat about 5 258 billion litres of waste water a day and about half of this amount is from Gauteng.

Of the 821 plants measured, 40 were awarded Green Drop status for excellent water quality while 78 were good and 243 were average. A total of 143 were delivering a very poor performance and 317 were in a critical state.

Dreamliner jets into Tokyo

The long awaited Boeing 787 Dreamliner has made its first flight to Japan and will undergo testing at All Nippon Airways before being commercially launched. The flight touched down at Tokyo's Haneda Airport having left Seattle the previous afternoon.

Boeing missed its original delivery date for the Dreamliner by more than two years and has repeatedly delayed its introduction because of development problems.

The twin-engine jet is made mostly from carbon fibre and other composite materials instead of aluminium and as a result is lighter and about 20% more fuel efficient than other mid-sized passenger airliners.

Boeing says that it has confirmed orders for 835 Dreamliners and hopes that it will deliver the first one to All Nippon Airways (ANA) by August or September this year. The airline has ordered 55 of the Dreamliners while Quantas and United Continental Holdings have each ordered 50 of the new planes. Japan Airlines has ordered 35.

Meanwhile the Airbus A350 – a model that competes directly with the Dreamliner – is scheduled to enter service with Quatar airways in 2013. Airbus says it has nearly 600 orders for the new airliner that is also made mostly from carbon fibre and composites.

ANA is the world's eighth-largest airline by revenue and it considers the Dreamliner an integral part of its expansion plans because it has a longer range, is more fuel efficient and will be used by it on new long-haul routes that were previously not commercially viable.

According to Boeing, the Dreamliner provides higher levels of passenger comfort because the air pressure in the cabin during flights is equivalent to 1 800m rather than 2 400m. It is also equipped with larger windows and extended overhead luggage space.

During the week-long tests the Dreamliner will be used on various domestic routes out of Tokyo and maintenance crews will be able to perfect the refuelling, towing and routine servicing operations.

Electricity distribution nightmare for Eskom

Eskom is facing a R50-billion nightmare because of a backlog of investment in maintenance of the existing municipal electricity distribution network.

The lack of investment follows a decade of indecision on regional electricity distribution, the formation of EDI Holdings and then its disbandment in March this year. Only one regional electricity distributor went into operation in 2005 in Cape Town but the council refused to transfer its infrastructure to the organisation and as a result it never began distributing electricity.

Doug Kuni, managing director of the South African Independent Power Producers' Association, says that without hefty investment in the distribution network, more and more power outages will occur as the municipal infrastructure is worn and can no longer cope.

He says that power outages experienced in the Johannesburg area this year are testimony to overloading of the network and caused, in part, by the many thousands of illegal connections that have been made to the grid.

Over the past ten years, municipalities around the country have stopped investing in distribution infrastructure and maintenance because they feared that their investments would be handed over to regional electricity distributors and they would receive no benefit or compensation.

Cornelis van der Waal, an analyst at Frost & Sullivan, says that a lack of skills within municipalities is also to blame for the deterioration of the distribution network.

He says that some of the well-managed municipalities face ongoing problems because they do not have the skills to maintain the infrastructure.

Eskom's Brian Dames says that the capacity expansion plan will mean that South Africa has enough electricity for the next 20 years but he points out that the ailing distribution network will compound problems facing the electricity utility.

Meanwhile, Richard Worthington, a climate change programme manager at the World Wide Fund for Nature says that municipalities must reintroduce ripple controls to allow for a more efficient management of electricity so that non-essential use of electricity can be controlled during periods of peak demand.

Cape Town to get desalination plant?

Cape Town may embark on an ambitious desalination scheme to provide water to residents of the city and it has called for tenders for a feasibility study of this desalination plant. Strong population growth has placed considerable strain on the city's ability to provide water to residents in Cape Town, Stellenbosch, Drakenstein, Swartland and Saldanha.

According to the Department of Water Affairs, the water system in the Western Cape can provide 556-million cubic metres of water a year but demand has already risen to 511-million cubic metres a year.

Integrated water resource planning chief director Peter van Niekerk says the desalination study will determine the best location and size for such a plant. He warned consumers that the Western Cape could run out of water in the years ahead unless significant water savings were implemented and new sources of water were found. He says that a further study will be conducted into the re-use of water, which he described as the only remaining major source of water for the province. The recycling of water supplies would be less costly than building a desalination plant.

Van Niekerk says the re-use study will start within the next few months and will run in tandem with other investigations into using groundwater resources and the Table Mountain Group aquifer. The city has yet to decide whether to sink a pilot well into this groundwater resource.

Other options are being considered by the Department of Water Affairs, one being to pump winter rainfall run-off from the Berg River to the Voelvlei Dam and divert winter rainfall – above an agreed threshold – from Mitchell's Plain to the Klein Berg River and into the Voelvlei Dam.

The Department has warned Western Cape residents that the only short-term solution to water shortages in the province is to implement meaningful savings by curbing waste and water losses.

Gaming worth R20-billion to SA's economy

South Africa's gaming industry is pumping R20-billion into the South African economy each year according to figures released by the Gambling Review Commission. Gaming includes casino gambling, bingo, lottery ticket sales and the use of limit pay-out machines.

The figure is almost double the level it was at ten years ago. The commission says that National Lottery tickets worth about R4-billion are sold each year and after the deduction of prizes means that about R2,2-billion is available for investment.

In 2009, lottery products contributed R480-million in VAT and placed R1,4-billion with charities. The commission was established by the Minister of Trade and Industry, Rob Davies in 2009.

The Gambling Review Commission tabled its first annual report in Parliament. Figures show that gambling is growing by about 9% a year compared with the overall economic growth in the country, which is at just 4%.

There are 51 317 people employed by the casino sector in South Africa and a further 34 377 in other gaming operations. A further 16 680 people are employed in associated leisure and entertainment operations, making it a significant employer in South Africa's economy.

The betting industry is considerably smaller and employs 2 364 people, including bookmakers, but this does not include the almost 100 000 jobs that are associated with the horse racing sector in South Africa.

The commission says that the horse-racing sector comprises all activities associated with racing including the manufacture of feeds, veterinary services and the breeding, training and racing of horses.

Referring to limited pay-out machines, the commission says that there are about 2 500 people employed in this sector and another 400 involved directly in bingo games.

Davies told Parliament that the current limit of 40 casinos throughout the country was "appropriate" and suggested that it should be maintained at this level.

The commission says that 38 of the 40 licences have been issued so it is possible that two new casinos could be established somewhere in the country at some future time.

TELECOMMUNICATIONS RESEARCH GROUP

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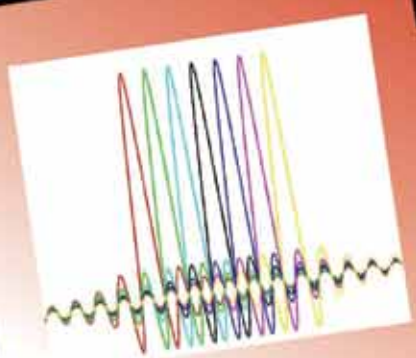

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UNIVERSITY OF JOHANNESBURG

Replaceable you:
the geeks guide to becoming a cyborg

by Gavin Chait

On 10 March 2011 Craig Lewis, a 55-year-old waste-water engineer from the city of Houston, made history by becoming the first person to be simultaneously alive but without a pulse.

Lewis suffered from cardiac amyloidosis, a rare disease in which the body's major organs – especially the heart – become clogged with protein plaques.

With only a few hours left to live, Doctors Bud Frazier and Billy Cohn operated on Lewis, removing his heart and replacing it with two turbine-like continuous-flow Heartmate II ventricular assist pumps.

With few moving parts, a battery-life measured in hours, and weighing 450 grams, the Heartmate II has even been used in women and children.

The longest-surviving recipient of an artificial heart is Peter Houghton who received his Jarvik 2000 heart pump in June 2000. He became the world's first permanent recipient of an artificial heart, rather than merely as a bridge to a transplant. He died in November 2007 having lived 1 513 days without a biological heart.

Lewis only lived on for a month after his operation. However, neither Houghton nor Lewis died because of the failure of their ventricular assist devices (VADs). Their other organs failed. "These pumps don't wear out," says Dr Frazier. "We haven't pumped one to failure to date."

Life giver: Doctors at the Texas Heart Institute have already tested an artificial heart that doesn't have a beat or produce a pulse. The new type of artificial heart uses spinning turbines that keep blood flowing at a steady pace rather than the rhythmic beat present in current implants that seek to replicate the method of a normal human heart.

For the aspiring cyborg, just how much of yourself could you replace and still be alive?

Let's start at the extremities and work our way in.

Oscar Pistorius, South Africa's "fastest man on no legs", famously uses a set of carbon-fibre transtibial limbs, called the Cheetah Flex-Foot and made by Iceland's Ossur.

The Flex-Foot is a performance limb and so not really useful for walking about, but it does indicate the state of the craft.

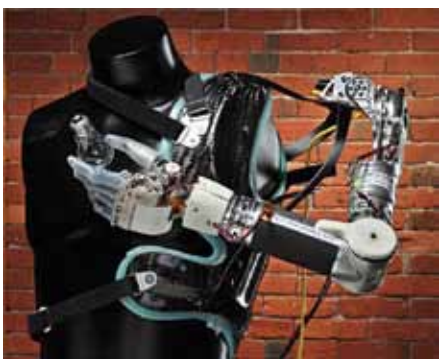
One of the most sophisticated prosthetic legs is Ossur's Power Knee, motorised and electronically-controlled, which can provide a power assist when standing and walking up slopes or stairs. It also provides a more natural proprioception response; the device is able to match itself to your gait. Other similar devices include Otto Bock's C-Leg, Freedom Innovations' Plié Knee and DAW Industries' Self Learning Knee.

The prosthesis has come a long way since Long John Silver's peg leg, however, the interface between the device and the wearer's stump still has the potential to cause pain and infection. Wearers must consider suction – the force with which the device will remain attached during movement – and comfort. Prosthetics may last a lifetime and so spending a great deal on one may be justified, but the liners are an ongoing expense.

There are whole-limb replacements which also include prosthetic feet. Joints such as ankles, knees and hips can also be replaced. The process of joint replacement is about resurfacing the main bones responsible for articulation. Usually this is necessitated by the breakdown of the cartilage protecting the bones, resulting in tremendous pain and limited mobility.

The joint is cut open and the bones making up the joint are cut into shape to prepare them to accept the new replacement. The metals are usually cobalt chromium combined with titanium, which is biologically neutral and designed to encourage bone regrowth. There are complications with this and some patients have developed pseudotumours in response to the metal. As with external prosthetics, the danger comes from the interface between the new metal joints. A range of interfaces are available: metal on polyethylene, metal on crosslinked polyethylene, ceramic on ceramic, ceramic on crosslinked polyethylene, and metal on metal. Each has advantages and disadvantages and none is a permanent solution. If you have a joint replacement, chances are you will have to go in for surgery every five years or so to replace the interfaces or even replace the entire joint.

The greater complexity of replacing hands and arms is also quite advanced. Dean Kamen, inventor of the Segway, is working on a brain-controlled robotic arm called the 'Luke Arm' (after Luke Skywalker) and has already received funding from DARPA. There are many others working in this area.



Limb and joint replacement are interesting, but not for the geek truly interested in becoming a cyborg. For that we need to consider the replacement of the major organs.

All implantable devices suffer to some degree of difficulty with biocompatibility; the human body just isn't used to having synthetics built in. The chemical soup that is your metabolic system tends to interact with plastics and metals in unexpected ways. Designers of devices have to consider the total combination of materials in the region of the body where they will operate. Such biocompatibility is often a limiting factor that can cause even acceptable replacements to fail.

Kidneys maintain the body's internal equilibrium of water and minerals, including excreting of acidic metabolic products that cannot be removed via respiration. The kidney also produces the endocrine hormones of erythropoietin, which controls red blood cell production, and calcitriol, which controls calcium uptake and release for bone formation. It is a complex organ to replace.

In 1943 – the height of Nazi occupation of the Netherlands – Dr Willem Kolff, a Dutch physician, built a dialysis machine out of sausage casings, beverage cans, a washing machine and whatever else he could find. Over the next two years he tested his primitive dialyser on 16 patients. None survived. Then, in 1945, he had his first success.

Dialysis works by the diffusion of solutes across a semi-permeable membrane. Blood passes by a membrane against the flow of the dialysate flowing on the opposite side. Smaller solutes and fluids pass through the membrane while red blood cells and large proteins remain in the blood system. The dialysate must be continuously replenished to ensure that the diffusion gradient remains constant. In haemodialysis the blood is pumped out of the patient's body and into a haemodialysis machine where it is processed and then returned. The process is lengthy and intrusive and hardly counts as an organ replacement. The alternative is peritoneal dialysis where a permanent catheter is implanted into the abdomen. The peritoneum is the membrane surrounding the abdomen that is used as the membrane across which fluids are exchanged from the blood.

The catheter is used to remove fluid and replace it with new dialysis fluid. The catheter itself has the potential to cause problems as it allows infection to cross into the body. Fluid must be carefully controlled. Too much can cause pain as well as causing the body to cool dangerously, while too little can lead to a loss of efficacy and poisoning.

This is still not a kidney replacement, but it is a useful interim measure. There are research projects, such as a peritoneal-based autonomous wearable artificial kidney (AWAK) from the University of California, and the Vicenza Wearable Artificial Kidney

Visio 2010
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Four Reasons to Try Visio 2010

1. **Simplify large and complex diagrams.** Add clarity to diagrams using Subprocess and Containers to group related shapes visually and logically. As a diagram grows larger or becomes more complex, Subprocess and Containers help you keep information more organised and understandable.
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The world is more complex than ever, and people need an easy way to simplify information, communicate it to others and ultimately make better decisions. Diagramming has always been a way to help organise information into easy-to-see, digestible parts. Whether on napkins, white boards or paper, diagramming helps convey thoughts and ideas.

"Humans have always communicated visually, to make sense of the world and communicate quickly with others."
James Avenant

That's why the diagram is so powerful, and even more relevant in today's fast, global, news-intensive society. "What is lacking from today's diagrams are the operational data that contextualise the diagram at a point in time," said James Avenant, who heads the Microsoft Visio business at Microsoft South Africa.

Whether it's a network diagram, floor or plant layout or a business process, the latest tools in Visio 2010 help create visually-pleasing diagrams that simplify complexity and get everyone on the same page. With a large collection of pre-drawn shapes, pictures and templates, and the dramatically improved user experience, every step is easier and more intuitive.

What's new?

Since Visio 2007, users can connect external data to their Visio diagrams with Visio "data graphics". While this is an excellent way to visualise your data, it was limited to the desktop. In Visio 2010, this limitation is removed when the diagram is published to SharePoint.

This increases productivity by bringing together separate silos of information—such as a business process diagram and the operational data related to that process—into a single, up-to-date view, saving time and speeding up decisions. The icons, symbols, colours and bar graphs give a clear view of the information that matters to your business—and automatically links to popular data sources such as Excel and Access to help you display visuals that are always current.

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being developed in Italy. However, none are ready for clinical trials just yet.

Lungs similarly require diffusion across a semi-permeable membrane as blood passes via the alveoli and oxygen enters the blood while CO_2 leaves. The first artificial lung was developed for use in heart surgery in 1951 when Dr Clarence Dennis attempted the first open heart operation using such a device at the University of Minnesota Hospital.

The first lung machines introduced oxygen to blood directly by bubbling air up through the fluid. This caused trauma to the blood cells known as haemolysis in which the cell walls break. Obviously this will be inefficient and potentially fatal. More modern lung machines use high-performance microporous hollow-fibre oxygenation membranes to separate the blood from the oxygen flow.

Artificial lung research is well advanced with two-year-old Owen Stark becoming the first infant to undergo emergency lung replacement in June 2010. Owen's lung is made by Novalung Germany and works without a pump, relying on the heart to pump blood through the system. It is attached via a shunt between the main pulmonary artery and the left atrium of the heart. After 23 days Owen was removed from the device and remains under treatment.

The research behind the Novalung is led by Robert Bartlett, a surgeon at the University of Michigan Medical Centre and Michigan Critical Care Consultants based in Ann Arbor. The objective is to create a device that can provide all of the patient's oxygen needs powered entirely by using the heart's pumping power. It has taken eight years and they believe they are now there.

Bartlett's BioLung is a little larger than a beverage can and is implanted in the chest. The heart pumps blood through the device which is filled with hollow gas-porous plastic fibres.

As in the lung, oxygen and carbon dioxide diffuse across the membrane in opposite directions and the blood then continues back through the heart. The US National Institutes of Health has recently granted Bartlett $4.8 million to continue research towards clinical trials.

The liver is another complex organ responsible for detoxification, protein synthesis and production of biochemicals used in digestion. You may be able to survive with a weakened heart, one kidney and one lung, but a weakened liver will kill you.

So complex are the hepatocytes which make up the liver, that there isn't any form of artificial liver device – implantable or not – in production. Three approaches are currently undergoing clinical evaluation.

The University of Rostock in Germany is testing its Molecular Adsorbents Recirculation System (MARS). This uses two circuits. The first uses human serum albumin passed via a semipermeable membrane to remove ammonia, bile acids, bilirubin, copper, iron and phenols from the blood. The second circuit uses haemodialysis to clean the albumin before recirculating it. This system has been approved for drug overdose treatment since 2005.

Single Pass Albumin Dialysis is similar to dialysis performed for kidneys but the solution is albumin and is discarded.

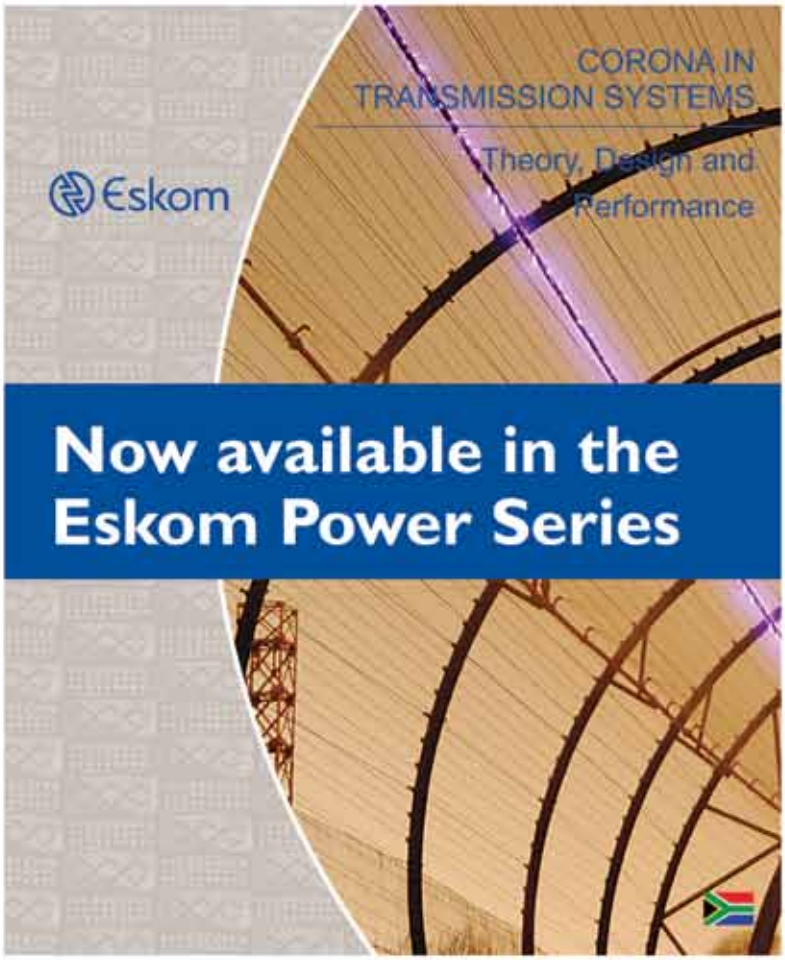
Fresenius Medical Care in Germany is testing its Prometheus system which combines albumin adsorption with high-flux haemodialysis after filtration of the albumin fraction through a polysulfon filter.

These devices still don't come close to the utility of a real liver and the University of Minnesota is working on a bioartificial liver. Their approach is quite clever. They fill a membrane-based cartridge similar to that used in kidney dialysis with pig liver cells suspended in a cold collagen solution. The cartridge is connected to a tubing circuit and warm medium is perfused outside the fibres. This allows the collagen to gel and the liver cells to contract to 60 percent of their size creating a space for fluid flow. This can then be hooked up to the patient.

The membrane allows toxins to diffuse out but prevents the immune system from responding to these alien cells. This is still in early stage investigations but offers tremendous scope.

The pancreas produces most of the endocrine hormones, including insulin and glucagon, as well as an exocrine gland, secreting pancreatic juice containing a range of digestive enzymes. Diabetes is only one of the many illnesses that can result from a faulty pancreas.

The first infusion pump for parenteral drug infusion was developed in a landmark 1977 paper from the University of Minnesota. "Although the continuous infusion of insulin is and was a perfect way to control



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Treatment of the physical, analytical and experimental aspects of corona performance of ac and dc transmission lines is presented in this book. Example calculations are included throughout in order to provide a better understanding of the analytical techniques presented and of the orders of magnitudes involved. Explanatory photographs, diagrams, tables and graphs complement the text. Development of criteria and methodologies for the corona design of ac and dc transmission lines and their application to typical cases are also described.

This book is a valuable resource for transmission line design engineers and for those involved in carrying out corona research studies as well as for developing university undergraduate and graduate courses.

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the swings in blood sugar associated with diabetes, the patient had to maintain quite a stable carbohydrate intake in order to avoid hypoglycemia, so this method of management of severe diabetes did not develop into a standard treatment because of the problems of sensing blood glucose and servo-regulating the pump infusion rate based on measured glucose. However, the concept of a continuous infusion pump powered by compression of a gas to a liquid below a flexible diaphragm is a superb example of bioengineering," says Dr Bartlett, creator of the artificial lung.

The infusion pump isn't perfect and research has continued into developing a bioengineered approach. This would create tissue containing islet of Langerhans cells, which are responsible for insulin production. These cells can, as with the bioartificial liver, be encapsulated to prevent the body's immune response from attempting to destroy the artificial replacement.

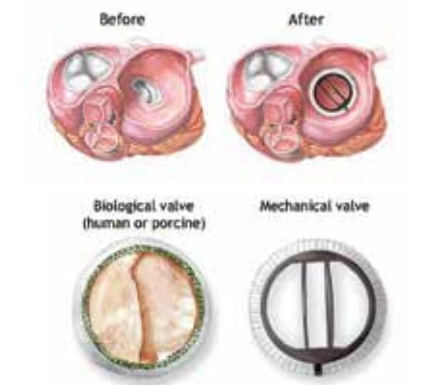
This is also a control problem requiring continuous blood glucose monitoring. At present, a diabetic must monitor his or her blood sugar manually by taking a fingerstick blood sample.

Real-time monitoring would close the loop between the patient measuring and then administering the insulin. The first human trial of an implantable pancreas is taking place in France where Medtronic's MiniMed long-term glucose sensor and its implantable insulin pump are being tested.

While the insulin pump works for about eight years after implantation, the sensors currently only last about nine months.

However, this is an artificial organ that looks to be created soon.

Less obviously, cardiac valves, vascular grafts, artificial tissue and skin are all being developed. There is even an artificial bladder that uses laboratory-grown living replacements.



Cardiac valves.

Vascular grafts.

Artificial tissue.

Now for the organs you probably think can't be replaced: the brain, the eye and the ear.

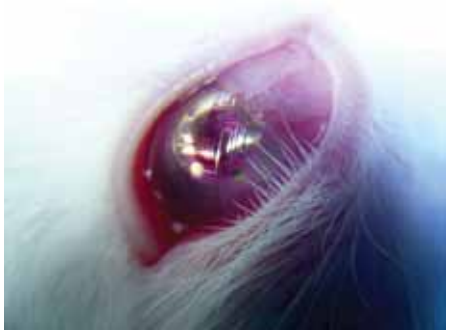
The cochlear, or bionic, ear has been implanted into over 188 000 people worldwide and can partially restore hearing in patients suffering from deafness as a result of cochlea sensory hair loss. The sound quality isn't particularly good, and music is still inaudible, but hearing something – however indistinct – is better than nothing.

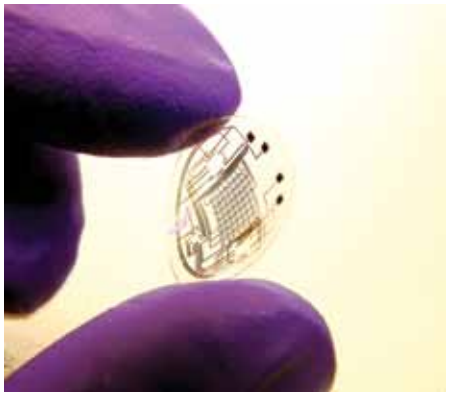
Graeme Clark at the University of Melbourne developed the Australian prototype bionic ear, implanted in Rod Saunders in 1978. The initial processors were large and

strapped externally. However, as microelectronics has advanced, the processors have become smaller. The first implantable cochlear device was placed into three recipients in Australia in October 2005.

There are a large number of research projects focusing on artificial eyes, from the supportive such as the bionic contact lens, to replacement electronic eyes. The contact lens uses electronic circuits only nanometres thick, LEDs one-third of a millimetre across and a self-assembly process using capillary forces. The experimental project was developed by Harvey Ho at the University of Washington.

Bionic eyes depend on the nature of the sight loss. Retinal prostheses are the easiest since the retina is relatively simple to reach and vision loss due to degeneration of photoreceptors easiest to treat.





Creating artificial vision involves hooking up the optic nerve to a receiver. As in developing of digital cameras, the larger the number of receptors in the array the greater the resolution. However, this implies connecting up a large number of nerve cells. Doctors Mark Humayun, Eugene DeJuan and Robert Greenberg performed the first proof of principle investigations at Johns Hopkins University in the early 1990s. Their first generation implant had 16 electrodes and was implanted into six test subjects between 2002 and 2004. Five of these patients still use the device. Second Sight, the company set up to commercialise this research, has begun Phase II trials of a second generation 60 electrode device.

Other approaches involve embedding a retinal prosthesis into the eye. The Tubingen project at Germany's University Eye Project uses microphotodiode arrays connected to an external power supply. The Massachusetts Eye and Ear Infirmary and MIT have a similar approach.

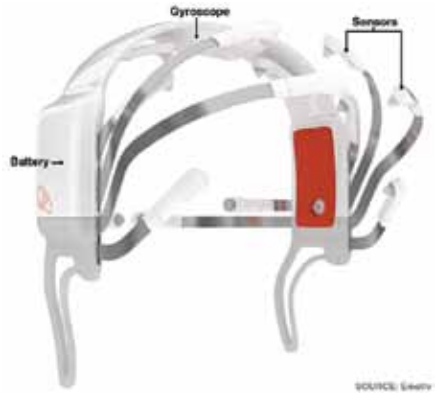
Dr Mohamad Sawan at the Polystim Neurotechnologies Laboratory in Montreal is developing a device to be implanted into the visual cortex in the brain. This will receive stimulus from an external controller consisting of stereoscopic micro-cameras worn over the eyes.

The field of Brain-Computer Interface (BCI) was first developed at the University of California Los Angeles in the 1970s. Implanted prostheses in the brain are, after adaptation, handled like a natural sensor or effector channel.

Miguel Nicolelis pioneered work in implanting electrode arrays into monkey brains to control robotic arms. In 2008, Dr Nicolelis's lab completed an experiment where a monkey controlled a robot on a treadmill in Kyoto, Japan.

The first human neuroprosthetic devices implanted in humans were produced in the 1990s. A number of companies have developed products utilising BCI for a range of applications, from assisting the physically disabled, to enhancing computer game experiences.

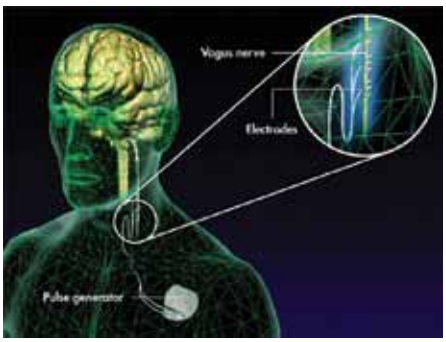
In 2008, US/Australian firm Emotiv, demonstrated a non-invasive electroencephalography (EEG) headset that can read neural activity and interface with a computer-game. "Emotiv is a neuro-engineering company and we've created a brain computer interface that reads electrical impulses in the brain and translates them into commands that a video game can accept and control the game dynamically," says Tan Le, president of Emotiv.



"This is the first headset that doesn't require a large net of electrodes, or a technician to calibrate or operate it and doesn't require gel on the scalp," she says. "It also doesn't cost tens of thousands of dollars."

In 2009 Dr Christopher James from the University of Southampton's Institute of Sound and Vibration Research demonstrated the potential for people suffering from 'locked-in' syndrome to communicate, one letter at a time, via an experimental BCI system.

In other words, getting the brain to learn new tricks and interface with external devices isn't impossible. Brain pacemakers are implanted to reduce and control epilepsy, Parkinson's Disease and even major depression.



This builds on the work of Professor Helen Mayberg, of Emory University School of Medicine in the US, who first began studying the use of deep brain stimulation for depression 15 years ago.

None of these devices are perfect replacements for the organs they displace, and they're a long, long way from being better, but they do allow a person to live longer and survive the failure of parts of their anatomy.

Being a perfect cyborg is still decades away but you'll be glad to know that the technology is under development.

The implications of transgenic and cybernetic humans

by Gavin Chait

"A complete DNA read-out for every newborn will be technically feasible and affordable in less than five years, promising a revolution in healthcare," said Illumina's CEO, Jay Flatley, in February 2009. "By 2019 it will have become routine to map infants' genes when they are born."

The current Illumina technique costs around $19,500 for a full genome sequence, however, numerous companies are offering comparative genomics tests at a fraction of the price. These test only for a small subset of genes and use statistical methods to infer the total genome. Their utility remains controversial but that hasn't stopped a wide range of companies offering services.

Google-supported 23andMe charges $399 to test for 178 diseases and conditions. deCodeme.com charges $2,000 to test for 47 diseases.

The problem with identifying genes is that they are just potentials. They are a probability, not a certainty. The full interaction and expression of genes is unknown. Many factors appear to be expressed as a result of nurture rather than just nature. "In some cases it is difficult to distinguish if the detected sequence variant is a causal mutation or a neutral (polymorphic) variation without any effect on phenotype. The interpretation of rare sequence variants of unknown significance detected in disease-causing genes becomes an increasingly important problem," says Czech medical geneticist Eva Macháckova.

The US has already passed genetic non-discrimination laws to prevent insurers and employers from excluding people based on their genes. Worse, though, a world in which genes and artificial organs can be cheaply and easily produced is also a world in which hackers will derive tremendous fun and profit from attacking such systems. Every year some 300 000 people receive medical implants. Most of these – defibrillators, pacemakers, drug pumps and more – are controlled wirelessly. Doctors can monitor and adjust the devices in situ. In 2008, researchers at the University of Massachusetts discovered that these devices can be hacked.

"You might have people listening to a signal from a patient's device to get private medical information from the patient or even send commands to the device," said Dina Katabi, an associate professor in MIT's department of electrical engineering and computer science. A nightmare scenario is a hacker commanding a drug pump to administer to killer dose, or a defibrillator to produce a lethal shock.

None of this has happened yet but Katabi and her team have developed a system to handle encryption and authentication via these implantable devices. "A trusted external device that wants to communicate with the implanted device communicates authenticated and encrypted messages to the shield. The shield then conveys these messages to the medical implant and also prevents non-authenticated messages from reaching the implant," says Katabi.

In "They can hear your heartbeats: non-invasive security for implantable medical devices", Shyamnath Gollakota, Haitham Hassanieh, Benjamin Ransford, Dina Katabi and Kevin Fu from MIT and the University of Massachusetts take their research further. "The shield uses a novel radio design that can act as a jammer-cum-receiver. This design allows it to jam the IMD's messages, preventing others from decoding them while being able to decode them itself. It also allows the shield to jam unauthorised commands - even those that try to alter the shield's own transmissions."

Shielding medical devices is one thing but desktop production of DNA is another matter altogether. Epoch Lifescience based in the US offers 39 US cents per base-pair transcription of synthetic genes. GenScript offers 29 US cents per base-pair. There are also numerous online databases which allow you to view all currently-available gene sequences. Coding your own genes from a home pc is only a few clicks away.

Legal systems are still grappling with the difficulties of intellectual property where three-dimensional objects can be cloned in sintering devices, and where the Internet has offered easy and relatively anonymous copying and distribution of any digital media.

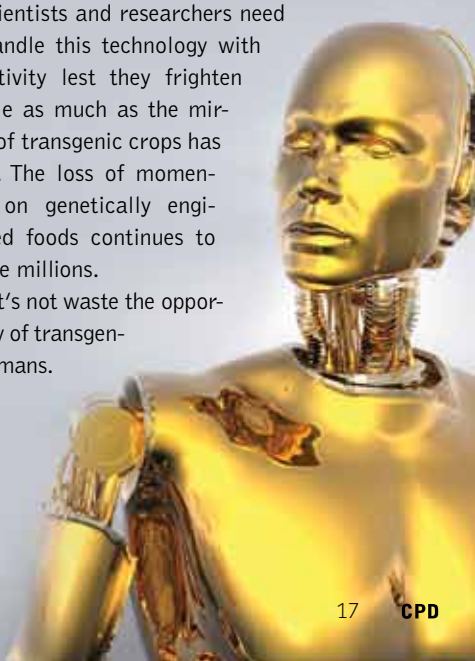
The potential from these new technologies is profound, extending our lifespans and offering the opportunity to overcome our genetic limitations. The explosion in ideas and innovation that followed the easy collaboration of software programming will be nothing in comparison to similar biotechnology collaboration.

There is also the potential for tremendous harm as governments act – or over-react – to the potential for danger. Right now the devices are expensive and beyond the average delinquent but even desktop computers were expensive once.

Beyond these matters though is one greater; the nature of humanity. For those people who believe that life is the gift of a mysterious creator, the commoditisation of our fundamental biology places demands on their beliefs that can cause a very fearful response.

Scientists and researchers need to handle this technology with sensitivity lest they frighten people as much as the miracle of transgenic crops has done. The loss of momentum on genetically engineered foods continues to starve millions.

Let's not waste the opportunity of transgenic humans.



UJ to build solar panel plant in Stellenbosch

The University of Johannesburg's intellectual property company, PTIP, is to put R120-million into building a semi-commercial plant to make thin-film solar electricity panels that were developed by its Professor Vivian Alberts.

The university has been negotiating with Sasol, Venfin and the government to build a R1-billion plant at Paarl that will make the panels, which are as thin as a human hair. PTIP says that the technology it uses makes the panels easy to manufacture, cheaper and more efficient than competing silicon panels.

Sasol withdrew from the project saying that it had to invest in coal and gas-to-liquids plants instead and, as a result, the R1-billion plant planned for Paarl had to be shelved.

Using money that it received from German and Chinese licence holders to the technology, PTIP will now build a plant at the Stellenbosch Technopark to prove the viability of manufacture. It will use new ovens developed in Germany that allow quicker and more efficient levels of production.

PTIP says that the plant will be "scaleable" so that once the university has demonstrated its viability to the investment community it will be able to rapidly increase output and treble in size relatively quickly.

Professor Alberts' technology is based on copper iridium gallium that provides economic and efficiency advantages, is a semi-conductor and, over time, is carbon negative.

Bosch in Germany holds the licence to Alberts' technology as does Chinese company Sunvim.

According to a survey conducted by Time magazine last year, solar energy production grew by 67%. General Electric, one of the largest engineering companies in the world, created a joint venture with First Solar to build the United States' largest solar panel factory costing $600-million.

GE will also produce thin-film panels but its technology is based on using cadmium telluride. GE says its panels are better than most others but no-one has yet tested them against those designed and built by Professor Alberts.

GE bought the wind turbine assets of bankrupt Enron and developed it into a $6-billion business. It is hoping to the do the same with its solar technology.

R1-billion to RICA SIM cards in South Africa

South Africa's three mobile network providers have spent more than R1-billion between them on ensuring that subscribers are authenticated in terms of the Regulation of Interception of Communications Act (RICA).

But the government has acknowledged that there is still a problem – particularly with smaller, independent retailers – who have pre-registered SIM cards en masse in their names and then sell them onto people without getting the necessary details as required by the Act.

In terms of the Act, every subscriber is required to provide proof of residence and personal identity documents before being given a SIM card. The pre-registered cards mean that criminals can still buy a SIM card without providing identity documents or proof of residence.

While the problem has not yet been quantified, Deputy Justice Minister, Andries Nel says that there could be hundreds of thousands of people using incorrectly registered SIM cards.

Vodacom, MTN and Cell C say that they have achieved more than 95% registration under RICA for contract phone users and prepaid clients. Virgin Mobile and 8.ta say that they are 100% compliant.

Nel says that Cell C had 99,99% of its contracts and 97% of its prepaid clients registered while MTN was in second spot with 99,5% of contract and 97% of prepaid users registered. Vodacom was in third spot with 98,98% and 95,12% respectively.

MTN's Robert Masonga says that the company spent R250-million on RICA marketing while Cell C says it spent between R300-million and R400-million. Vodacom has not given a precise figure but says it spent hundreds of millions on the process.

Anyone using a SIM card that is not registered in terms of the law could face a fine of up to R60 000 and a period in prison. For service providers who have not complied with the RICA legislation the fine is R100 000 a day for each day the law was transgressed.

There are about 50-million SIM cards registered in terms of RICA. There is no limit on the number of SIM cards that can be registered in a person's name but that person is not allowed to sell the SIM card without the required authentication processes.

Airbus unveils plans for transparent planes

Airbus has unveiled plans to build the world's first transparent airliner with a see-through cabin that will allow passengers to see the world surrounding them as they fly.

The plane has what is called an 'intelligent wall membrane' that will support interactive games. It may be ready for use by 2050.

The futuristic concept vehicle was unveiled by Charles Champion, Airbus's vice president of engineering at the Royal Observatory in Greenwich. In the concept plane the business and economy zones are replaced with a zone for relaxing at the front of the plane.

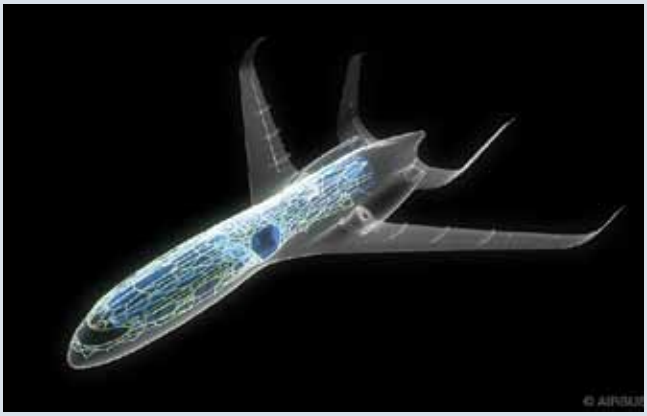
There is a fully-stocked bar for socialising and, towards the rear of the cabin, a working area for people who want to do some work while flying. All the small windows have been removed and replaced by a wrap-around observation area providing panoramic views.

The walls of the aircraft change according to the light conditions. Holographic pop-up displays have been included for gaming purposes or to support other in-flight entertainment options such as movies.

Airbus says that most of the technology, including the moulding for the seats and the 'head-up displays' already exists but the company has not revealed how it plans to make the transparent skin that is used for the concept airliner.

The cabin will control the air temperature and will probably use a bionic structure similar to that in a bird's bones. Vitamins and anti-oxidants will be injected into the air while mood lighting, aromatherapy and acupuncture treatment will be a standard feature.

Champion says that passengers will be able to play virtual golf – or other sports – in the interactive zone on the plane. He says that research has shown that passengers will expect, by 2050, a seamless experience in air travel while still caring for the environment.



Flight of fancy: Artists impression of an x-ray of an 'intelligent' concept cabin of an aircraft of the future.

iPad sales hurt laptops

Apple customers have downloaded 15-billion applications from its iTunes App Store. The applications are used on the iPad, the iPod and the iPhone and prove that hundreds of millions of programs are being downloaded every month.

The company's App Store has 425 000 registered applications of which 100 000 are purpose-built for the iPad. Apple says that developers have been paid more than $2,5-billion as sales continue unchecked.

Meanwhile, Apple has dropped its subscription rules for publishers who make programs or offer subscriptions to their magazines. Previously the subscriptions had to be available through the Mac App Store and Apple demanded a 30% share of the subscription revenue. However, the company has relaxed this rule.

The iPad is already hurting sales of computers in South Africa says Christopher Riley, managing director of The Notebook Company, who points out that while the sales of iPads have been "absolutely brilliant" for Apple, they have negatively affected sales of netbooks and laptops for other manufacturers.

Analyst had originally predicted that the new gadget from Apple was unlikely to have an impact on computer sales but would create a niche market among Apple users who are generally loyal to the brand.

However, this forecast has been revised with analysts now saying that sales of iPads, tablet computers and similar devices have had a direct impact on netbook and notebook sales and they expect this trend to continue. PC sales dropped in the last quarter and some analysts say this is a direct result of the rise in sales of iPads and tablets.

According to the Bedford Report, global computer shipments fell in the first quarter of the year compared with a year ago, the first time they have been down in six consecutive quarters. Gartner and IDC reported similar declines of 1,1% and 3,2% respectively but Gartner suggests that sales will pick up again as the year goes by and will increase by 3% for the whole year.

Shipments of computers from Dell, Acer and HP all dropped in the first quarter of the year in South Africa compared with the same quarter last year.

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Radiation meters for Fukushima children

Authorities in Japan's Fukushima city – where the damaged Dai-ichi nuclear plant is situated – have distributed radiation meters to 34 000 children to monitor their exposure levels.

The decision to hand out these meters comes in response to growing concerns over the safety of children as the nuclear problems at the plant remain unresolved.

The meters, called dosimeters, will be given to children between the ages of four and 15. So far these meters have been distributed to schools and from September all school children will be given one. City official Koichi Kato says that other towns in the affected area have begun similar measures but Fukushima's plan is the largest to date. Kato says that the programme will be continued for about three months.

About 300 000 people live in Fukushima city, which is 60 kilometres away from the Dai-ichi plant. The government has already set up a 'no-go area' for 20km surrounding the site and a 10km ring around the plant itself where residents – particularly pregnant women – have been urged to take special precautions.

So far about 80 000 people have been forced to leave their homes, many of which are now deserted. Because Fukushima city is outside the area officially designated as being dangerous to health, many people are still living there and businesses and government offices are operating as usual.

But the residents are concerned about the possible health consequences of exposure to some form of radiation despite government assurances that the exposure levels are within acceptable limits. Children are particularly susceptible to the effects of radiation, and parents – supported by private lobby groups – have demanded that better measures are taken to protect them.

As a result the amount of time that children are allowed to spend outside has been limited and many sporting activities have been moved indoors.

The exposure levels of radiation at 20 millisieverts a year for children – considered normal in the adult population and equivalent to the radiation exposure that a person would receive from an X-ray – has been lowered to 1- millisievert per year for children.

Kato says that the meters will not protect children from radiation but will measure exposure over a certain period of time and, if these levels get too high, the children will have to be moved out of the area.

Phone hacking – defaults at fault

The phone hacking that rocked Rupert Murdoch's empire and led to the closure of the 168-year-old *News of the World* could be achieved in a number of different ways according to a spokesman for the Metropolitan Police in Britain.

The police have defined phone hacking as "the illegal interception of messages relayed by telecommunications that were not intended for the person who intercepted them."

The hacking process involves a number of techniques. One of these is to use the default codes, such as 1111 or 4444, that cell phone providers in Britain give to users to retrieve their voice mail messages. Many customers do not change the default code, allowing hackers to gain access to their messages.

To access the voice mail messages, one caller would call a specific number to engage the line. Immediately, a second caller would call the same number and be diverted to the voice mail service. The default codes would then be used to gain access to all stored messages on the system.

These messages could be deleted to prevent anyone else from hearing them.

Another way to get access to messages is to call the voice mail number from a landline and enter the default codes to hear what messages have been left on the system.

If the owner of the phone had changed the default code then it was possible to get access to the message system by phoning the cell phone company and pretending to be the authorised person requesting that the code be reset to the default code.

In Britain, the three major cell phone companies, Orange, Three and T-Mobile, no longer provide default codes for voice mail messages and users must set up their own passwords immediately they register with the network.

O2 and Vodafone will allow codes to be set only from those cell phones they supply to the customer. If the number is reset, a new code is sent directly to the phone. Both companies alert a customer if three failed attempts to access the voice mail box are made and they lock the service until a new password is entered.

Mentorship

The SAIEE is offering mentorship and advice to young engineers.

The offer comes at a time when our country is suffering a shortage of skills, and we believe that mentoring is an essential requirement in the training and development of the next generation of engineers.

If, as a member of SAIEE, you believe that you need a mentor you can request a mentorship service from the Institute.

The service will be of particular benefit to those young engineers working under the leadership of busy and pressurized engineers, who may not have the time to spend with the young engineers discussing and planning their career paths.

This service is particularly relevant to young engineers who are working in an environment devoid of engineers or with non technical managers. The young engineer may feel frustrated because he or she cannot benefit from the wisdom of an experienced engineer.

It will give a young engineer, the mentee, a chance to talk to a mentor, who will be his or her advisor, teacher and role model, away from the work environment. His or her mentor, matched to a similar profile, will understand the mentee's work and personal situation, having been there him- or herself.

The mentee will be able to discuss problems and frustrations with his independent mentor, who would have no stake in the outcome, and who would be able to provide an unbiased opinion and advice. The mentee might not be able to do so with his superiors, particularly if he is unhappy, and is considering an alternative career.

The mentor and mentee could arrange to meet regularly, but not too often, say a few times a year, when both should have enough time to listen properly to what the other has to say.

The mentor could recommend to the mentee what course of action to take without being too prescriptive while the final decision and the consequences remain with the mentee.

Among its more than 5000 members the SAIEE has many experienced engineers who are willing to act as mentors. They are are spread across the country and include engineers who are experienced in steelworks, furnaces, rolling mills, mining, manufacturing, electrical generation, transmission and distribution, through to light industrial, process control, instrumentation, telecommunication, robotics, automation, software development and engineering management of these sectors.

So if you feel that you would benefit by talking to a mentor, please contact Ansie Smith on the number below. She has a database to match the profiles of mentors and mentees.

Prospective SAIEE Mentors
If you feel you have the time and interest to help mentees, please contact Craig Smith on craigs@saiee.org.za or 011 487 9042
In addition you gain CPD credits, for when you are required to re-register.

Formula One – much more than just racing

Formula One racing technology provides practical benefits that end up in everyday applications, and one such company, McLaren Applied Technologies (MAT), has the responsibility of finding applications that can be adapted from the Formula One technologies built into their cars.

MAT has tied up with a cycling firm, Specialized, that will use its technology to build the ultra-light carbon fibre racing bike, Venge, believed to be the fastest racing bike made in the world today.

Specialized's research and development director Eric Edgecumbe says that McLaren's expertise in carbon technology and computing systems is exceptional and after spending a short amount of time at the company's Woking plant, Specialized said that it wanted McLaren as a partner to help it keep winning at the highest level.

The first time the bike raced, it won the Milan-San Remo race, which at 298km is the longest one-day race on the professional biking calendar.

However, there are lesser-known applications of McLaren technology used in other sectors around the world. For instance its telemetry system, which uses sensors to monitor data and make tiny adjustments in real time to a racing car's engine, aerodynamics and suspension, can be used to monitor people, says Geoff McGrath, head of the Applied Technologies department.

The firm has already experimented using this technology for patients who are undergoing a weight-loss programme at a clinic in Norfolk. The patients had sensors on their skin that transmitted data directly to doctors about every aspect of their activities, from eating to getting some exercise. Similarly, this technology has been used in Britain to train athletes, including those involved in track-and-field and canoeing, who are training for the next Olympics.

In canoeing, the sensors are fitted inside the paddles so that every time an athlete applies force to the water, the sensors measure it and transmit it back to a computer that is monitoring the athlete.

The instant feedback helps athletes to make more informed decisions about the amount of activity and training they undertake as well as how to change their technique and accelerate their development as a result.

The sensors were also fitted to a sleigh used by the British women's bobsleigh team, which won the Women's World Bobsleigh Championships at Lake Placid in 2009.

McGrath says that these sensors are not only valuable to athletes but can, in fact, be used in the workplace to ensure that employees behave properly, take care of themselves and are sufficiently healthy to deliver optimum performance while at work.

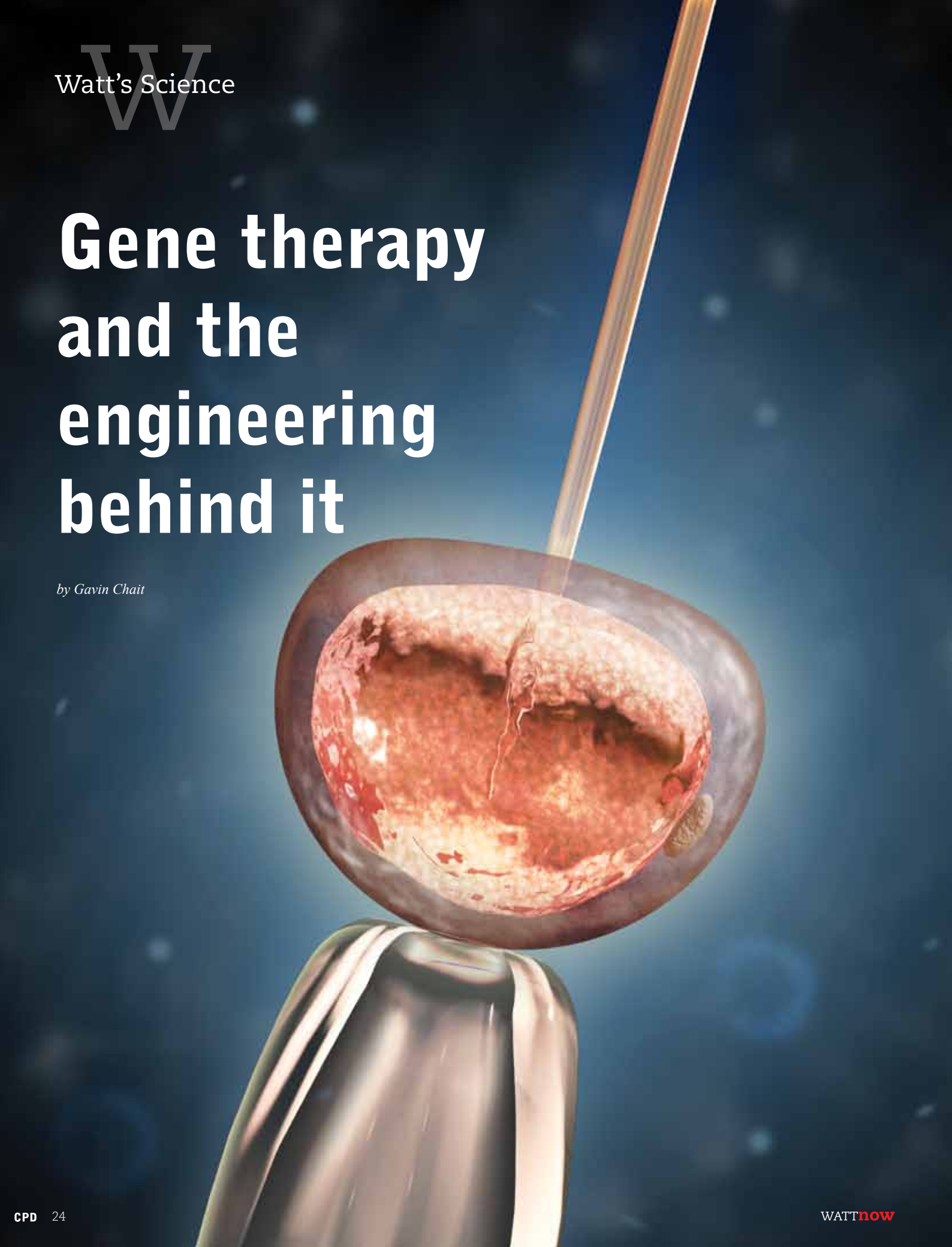
For instance, says McGrath, it's important for an executive to know when his or her stress levels are reaching unacceptable levels and that he or she might have to be cautious about how to react when attending an emergency press conference.

Turning to other technologies, McGrath says that McLaren has developed a flywheel energy storage system – an alternative to a battery in a hybrid car – that is already being used in the Porsche 911 GT3 Hybrid. He says that the flywheel is a great way to save fuel and this identical technology could be adapted for use on city buses, trams, heavy trucks and all other vehicles as a way of reducing total energy consumption.

McGrath says the company is now developing a much larger version of the flywheel technology that will be used to reduce the total energy consumption of metropolitan trains used on London's Underground.

Gene therapy and the engineering behind it

by Gavin Chait



Jesse Gelsinger was born with a rare genetic mutation that resulted in his liver being unable to metabolise ammonia, a by-product of protein breakdown. Ordinarily, the disease is fatal at birth but Gelsinger's mutation meant that some of his liver cells were normal. If he kept to a restricted diet and lifelong medication, he could survive.

At the age of 20, in 1999, he joined a clinical trial run by the University of Pennsylvania aimed at developing genetic therapies for infants born with genetic diseases. On 13 September he was injected with an adenoviral vector carrying a corrected gene. The intention was that the virus would infect his cells and replace his existing erroneous genes with the new version. Instead Gelsinger suffered a massive immune response to the virus, leading to multiple organ failure and brain death.

Four days after he was injected, he died.

The Food and Drug Administration found that the University had broken several rules of conduct during human drug trials, rather than there being some failure of the drug trial process itself. Still, Gelsinger became the first person to die of a gene therapy and the fledgling industry continues to suffer this legacy.

The science behind gene therapy is well founded. Many crippling and life-threatening illnesses have genetic origins and many of these are the result of an error in a single gene.

Haemophilia A is the result of defects in the F8 gene which codes for Factor VIII, essential for blood clotting. The loss of this single gene leads to deep venous thrombosis and pulmonary embolisms.

Combine this knowledge with what we know about viruses. Retroviruses – of which HIV is the most famous – introduce their RNA into cells along with reverse transcriptase and integrase. The RNA is transcribed into DNA via the reverse transcriptase and then inserted directly into the cell's DNA via the integrase. This results in a cell with a new gene that will happily replicate its function as if it were a native. It will also be transferred as part of cell division.

The question that scientists started asking was this: if we put the corrected genes into viruses, could we correct genetic diseases?

In 1972, Theodore Friedmann and Richard Roblin of the University of California and the Infectious Disease Unit at Massachusetts General Hospital wrote a seminal paper published in Science, "Gene Therapy for Human Genetic Disease?"

"In our view, gene therapy may ameliorate some human genetic diseases in the future. For this reason, we believe that research directed at the development of techniques for gene therapy should continue," they said. They also site an experiment performed in mice: "Munyon *et al* restored the ability to synthesise the enzyme thymidine kinase to thymidine kinase-deficient mouse cells by infection with ultraviolet-irradiated herpes simplex virus. In their experiments the DNA from herpes simplex virus, which contains a gene coding for thymidine kinase, may have formed a hereditable association with the mouse cells."

Stanley Cohen and Herbert Boyer, professors in biochemistry at Stanford and California Universities, collaborated in 1973 to insert a new gene into E. coli using Boyer's newly identified restriction enzymes, which permitted the isolation of specific genes. Boyer went on to found Genentech, the world's first biotechnology firm, and Cohen won the Nobel Prize in 1986.

The first geneticists needed a reliable vector for introducing genes and viruses – suitably denatured to prevent them causing illness – were perfect. Genetically modified crops were the first products: pesticide resistant corn, tomatoes that survive freezing, tobacco plants resistant to common viruses.

The first gene therapy in the US took place on 14 September 1990 at the National Institute of Health. Then only four years old, Ashanti deSilva was dying. She had been born with two errors in the genes that are responsible for producing adenosidedeaminase. ADA is required to ensure the supply of the Helper T white blood cells essential for a successful immune response.

Ordinarily, such a disease is treated with a bone marrow transplant, but Ashanti couldn't find a biocompatible donor. French Anderson, working at the NIH, felt that the time was ripe to try gene therapy in humans. Starting in June 1988, he began the regulatory process. "Over a period of seven months, seven regulatory committees conducted fifteen meetings and twenty hours of public hearings to assess the proposal," says the *New York Times*, from that time. Once approved, over a period of 12 days, Anderson and his colleagues extracted stem cells from Ashanti's marrow.

A retrovirus was used to insert a new copy of the ADA gene into the cells. On September 14 they began reintroducing the transgenic cells into her body. Within six months her T-cell count rose to normal. While Ashanti remains on low doses of PEG-ADA, the standard treatment for her disorder, her life has returned to normal.

ADA deficiency is known as the 'bubble boy' disease because of the isolation suits which many sufferers of severe combined immune deficiency experience. Research into this area continues.

And it isn't only genetic diseases that scientists are after. In May 2006, scientists at the National Institutes of Health treated metastatic melanoma in two patients using Killer T cells genetically targeted to attack cancer cells. Trichromatic vision in squirrel monkeys was restored in a September 2009 experiment, which may give a path to treating colour blindness in humans.

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spintelligent CLARION EVENTS

In 2008 GeroHutter at the Charite Hospital in Berlin successfully cured a patient of HIV by transplanting bone marrow deficient in a key HIV receptor. This can hardly be described as a mainstream cure as removing all bone marrow and replacing it is both painful and extremely dangerous, but it shows a way.

All of these experiments require sophisticated equipment and techniques.

The earliest of techniques developed for genetic engineering is that of polymerase chain reaction. This allows a small sample of DNA to be magnified several orders of magnitude. Kary Mullis, then working at Cetus Corporation in California, developed and patented the technique. Essential to the process is the working of Taq polymerase, isolated from thermophilic bacterium, which can withstand the high temperatures required to separate the two DNA strands and kickstart the copying process.

PCR was also the subject of a massive patent dispute but this didn't stop Mullis winning the Nobel Prize for his work in 1993.

The next technique is artificial gene synthesis in which oligonucleotide synthesis from digital genetic sequences is performed via an annealing process. It is this process that allowed the J Craig Venter Institute to create Synthia, the world's first synthetic life form.

The process involves stepwise addition of nucleotide residues to create a desired sequence. The description of this probably goes beyond a basic understanding of chemistry, so I'll not trouble you with it. GE Life Sciences produces a range of oligonucleotide synthesisers for large-scale production and numerous companies produce smaller versions for laboratory use.

The remaining techniques are transfection, transduction and protofection.

Transfection is the non-viral approach to introducing nucleic acid, the building blocks of DNA, into cells. A direct approach is that of the gene gun where DNA is coupled to an inert nanoparticle, usually gold, and shot directly into the nucleus. As you can imagine, this is a bit hit-and-miss. Many other transfection approaches are physical, such as impalefection where a nanofibre is used to pierce the cell, electroporation to create microscopic holes in the cell, optical transfection where a laser creates the hole, and so on.

Transduction is the transfer of DNA via a viral vector and protofection is the process of introducing foreign mitochondria – the body's energy generators – into cells.

But production of new DNA isn't the only useful spin-off from the gene therapy industry. Fabrication of gene microarrays is revolutionising medicine. Testing for illness is time-consuming and prohibitively expensive.

DNA microarrays, or gene chips, are used to measure the expression of large numbers of genes simultaneously. A microarray consists of a collection of spots of DNA sequences known as probes. These probes will attach only to their direct complementary target. A single array can contain tens of thousands of different probes and can dramatically accelerate such testing.

These can be used to identify cancer, disease profiles, genetic diseases or even perform full genetic sequencing.

All of this forms part of personalised medicine which is believed to offer the best hope for treating some of the more intractable illnesses.

In October 2006, the X Prize Foundation in partnership with the J Craig Venter Science Foundation, launched the Archon X Prize offering $10 million to "the first Team that can build a device and use it to sequence 100 human genomes within 10 days or less, with an accuracy of no more than one error in every 100 000 bases sequenced, with sequences accurately covering at least 98% of the genome, and at a recurring cost of no more than US$10,000 per genome." The final deadline is 4 October 2013.

Since then the race has been frenetic. Pacific Biosciences, Complete Genomics, GE Global Research, IBM and Halcyon Molecular have all thrown their hats into the ring. The world of Gattacca and fast genome sequencing is fast approaching.

All of these techniques are leading to a point where new gene combinations, proteins and even simple life-forms can be programmed much as a computer programmer turns out code. The science is on its way but the implications for our legal and social behaviours haven't even been opened.

Expect some chaos.

Live to 1 000 – it may be possible soon

The first person who is likely to live to the age of 150 has already been born and the person likely to reach the milestone of 1 000 years is probably likely to be born in the next few years, according to biomedical gerontologist Aubrey de Grey.

De Grey believes that scientists will have all the tools necessary to 'cure' aging and within the next 25 years will be able to bring it under a decisive level of medical control. He says such control is equivalent to the way that most infectious diseases can be controlled today.

He says that in future people will see their doctors for regular maintenance checks that will include gene therapies, stem cell therapies and immune stimulation methods. Other advanced medical procedures will be used to keep them in good shape.

De Grey says that aging is caused partly by a lifelong accumulation of various types of molecular and cellular damage that happens in the body. He says that procedures known as preventive geriatrics will be used to periodically repair molecular and cellular damage before it gets to be pathogenic.

To date the world's oldest person is living in Japan aged 122, but in 2010 that country had 44 000 centenarians and researchers say that, worldwide, the trend is that about three months in life expectancy is being added every year. Experts say that by 2030 there will be about a million centenarians living across the world.

Some academics have discounted De Grey's theories about aging and as a result the Massachusetts Institute of Technology offered a $20 000 prize to anyone able to prove that De Grey's SENS theory was "so wrong that it was unworthy of learned debate". However, the prize has never been won.

De Grey divides damage caused by aging into seven main categories for which repair techniques will have to be developed and says that stem cell therapy is designed to reverse one type of damage when cells die and are not automatically replaced.

He says stem cell products are already undergoing clinical trials. Referring to heart disease – another major killer – De Grey says that molecular 'garbage' contributes to heart disease and he is working with colleagues in the United States to identify enzymes that can clean out the cells.

He says that if this can be achieved then heart disease will simply not occur. De Grey points out that the focus of his work is not to keep people alive in a bad state of health but to prevent people from getting sick as a result of aging.

He says that the therapies currently being worked on by researchers are aimed at delivering long life as a side effect of better health.

He says that proper maintenance of the body – through gene therapy, stem cell therapy and targeted use of enzymes – would continue to work indefinitely and stop the aging process for millions of people.

Urban jungles store tons of carbon

Urban vegetation makes a major contribution to removing carbon dioxide from the atmosphere according to a new study conducted in Europe that set out to quantify how much carbon was stored within urban vegetation.

The study is being conducted to help European countries cut carbon dioxide emissions by an average of 80% by 2050.

For the study, researchers used information from satellite data and from field research to survey the amount of vegetation across Leicester in England, a city with a population of about 300 000 people.

Their assessment included domestic gardens, public spaces, road verges and derelict industrial land. The team estimated that 231 000 tons of carbon – equivalent to 3,16 kilograms per square metre – were locked away in the city's vegetation, mostly trees.

The team found that the carbon levels were roughly ten times more than expected and the amount of carbon was equivalent to the average annual emissions of more than 150 000 sedan cars.

Zoe Davis, from Kent University and lead author of the study, says that large trees represent significant carbon stores and she says that most of the publicly owned land in Leicester is grassland but if trees were planted there the carbon pool across the city would increase sharply.

She says that the assumption was that urban areas were assumed to contain zero levels of biological carbon density, but this is not the case. According to the researchers, the world's urban population has grown ten-fold in the past 100 years and now more than half of the world's population is living in urban areas. Davis says that as a result, urban areas are continuing to grow at a faster rate than any other land-use type.

About four percent of the world's total land surface is defined as urbanised but this figure is expected to surge as the human population continues to rise from the seven billion souls this year to 9,5-billion by 2050.

Bath's algae could be used to make biodiesel

Algae that have been growing in the Roman baths at Bath in England could be used to make fuel for cars, and researchers from the local university are carrying out studies on producing renewable fuels using algae in commercially viable quantities.

Extracting oil from the algae cells can produce biodiesel and PhD student Holly Smith-Baedorf says that one of the seven varieties of algae produced at the baths might be ideal for this purpose.

She says that algae are happiest at temperatures of about 25°C. This limits the number of places where they can be cultivated on a large scale, particularly as locations that are ideal are normally used for the production of crops.

The research team working at the baths comprises scientists from the University of Bath's department of chemistry. They are growing each species of algae taken from the baths in controlled temperatures.

The algae are believed to be the ideal research material for these studies because the temperatures in the baths are well controlled. The King's Bath keeps water at a constant temperature of about 46°C while in the Great Bath it is a steady 39°C.

Professor Rod Scott, working with the team, says that the results of the study will help to identify which species have adapted to growing at the higher temperatures required to make large amounts of biodiesel.

The research, however, is not confined to working with these species and the team is also looking for species of algae that have a weaker cell wall and a high oil content as these are easier to filter, reducing the amount of energy that it takes to harvest the algae from cultures.

Studies on the production of biodiesel using algae have been done for more than 20 years but the main problem has been that while biodiesel can be made, it can't be produced in sufficient quantities to make such a project viable.

Dead Sea sediment leads to rise in water levels

An Israeli company is planning to harvest salt from the bottom of the Dead Sea in order to protect a part of the southern shoreline and prevent rising water levels from flooding a group of hotels built there.

However, the cost of the project is estimated at about $2-billion and Israel's Tourism Ministry says that the work must be funded by Dead Sea Works, a subsidiary of Israel Chemicals, the second-largest company listed on the Tel Aviv Stock Exchange.

The company has apparently consented to taking part in the funding of the harvesting of salt but it says the state should pay the bulk of these costs. It says government estimates of $2-billion are way too high and that the actual cost of the harvesting operation will be considerably less than that. Israel's Prime Minister, Benjamin Netanyahu, promised that the government would "save the Dead Sea" and he decided that harvesting of salt was the best solution to stop the water levels from rising. He has now formed a special committee to determine the funding arrangements and set out the state's responsibility.

But Netanyahu has also implied that the government might resort to legal action against Dead Sea Works unless an amicable agreement with the company can be reached.

Bad water management has been blamed for the damage caused to the Dead Sea over the past 50 years and has seen its overall size shrink by a third. In certain areas, the shoreline has receded by about a metre a year.

It is made up of two lakes, the larger north basin and a smaller one in the south where water levels have risen. The southern basin is actually a series of artificial evaporation pools that are used by Dead Sea Works to produce potash, the main ingredient used in fertiliser.

The hotels that risk being flooded are on the edge of the largest pool, about 80 square kilometres. As a result of evaporation, salt sediment in the pool sinks, causing the water level to rise by about 20 centimetres a year.

By continually harvesting the salt sediment, Dead Sea Works hopes to keep water levels constant.

Dead Sea Works would harvest about 16-million cubic metres of salt from the evaporation pools and because of this the Tourism Ministry believes that it should bear the brunt of the costs and not rely on the State to foot the bill.

Uranium mine for Selous Game Reserve

Tanzania has confirmed that it will go ahead with plans to mine uranium in the Selous Game Reserve. Natural Resources Minister, Ezekiel Maige, told delegates at the United Nations World Heritage Centre meeting that it would mean that the park's size would be reduced by less than one percent.

The Selous Game Reserve has been proclaimed as a World Heritage Site and the UN has agreed to approve the plans to mine uranium there as long as environmental assessments are carried out first.

Maige says that some of the money made from the mining activity would be used to maintain the park. According to the United Nations cultural organisation, Unesco, the five million hectare Selous Game Reserve in the south of the country has large numbers of elephants, black rhino, cheetahs, giraffes, hippos and crocodiles and is relatively undisturbed by humans.

Maige says that mining companies could expect to earn about $200-million a year from mining uranium at the site and at least $5-million of this would be paid to the government. Some of this money would then be earmarked for the upkeep of the park. The new mines would create about 1 600 jobs.

Opponents of the scheme say that apart from the damage to the park itself, the Undendale Forest Reserve to the south of the park could also be affected by the mining activity. Because Selous Game Reserve is a world heritage site, the World Heritage Committee would have to approve plans for the mining project to go ahead.

The committee has asked that Tanzania's own assessment of the environmental impact of mining be approved by the country's environmental agency and then submitted to it for a final decision, which would probably be taken some time next year.

Maige says that all the studies undertaken so far have shown that there is no need for concern about radiation poisoning from the uranium extraction and that it will have little or no impact on the wildlife or the natural flora.

The mined uranium would be processed abroad.

Major oil find in Namibia will boost Western Cape

A major oil find on the Namibian coastline is expected to yield about 11-billion barrels of oil according to Namibia's Mines and Energy Minister, Isak Katali, with first production planned within four years.

Adrian Strydom, an executive at the South African Oil and Gas Alliance (Saoga) says that this will have a huge impact on the Western Cape as the region will be used as a service hub for the new field.

A recent study commissioned by Saoga indicates that the Western African offshore oil and gas market is expected to expand rapidly between now and 2013 with an estimated $150-billion being ploughed into maintenance and repair operations and acquiring the new skills needed to keep the oil fields productive.

President of the Cape Chamber of Commerce Michael Bagrain says that the discovery will represent a huge benefit to the Western Cape region as a whole, as Cape Town and Saldanha are the nearest industrial ports capable of servicing the oil fields. A single repair job on a vessel used by the oil fields typically generates about R200-million for the regional economy and employs about 2 000 people. While Saldanha has the facilities to accommodate large vessels, the problem is that Cape Town is a more attractive option because it has supporting engineering companies on its doorstep.

The huge oil find could mean that Namibia is soon producing as much oil as neighbouring Angola whose reserves are estimated at about 13-billion barrels. Katali says that Enigma Oil & Gas, owned by London-listed Chariot Oil & Gas, has identified 11 prospect sites along the southern coast and the largest of these, the Nimrod Prospect, has reserves estimated to be greater than four billion barrels.

Brazilian company HRT Oil & Gas has also certified that it has identified sites with potential reserves of 5,2-billion barrels and another site, Delta Prospect, being explored by Arcadia Expro Namibia and Tower Resources, has recoverable reserves of about two billion barrels.

Neptune celebrates its first birthday

On July 12 Neptune celebrated its first birthday as it was exactly one Neptunian year – or 165 Earth years – since its discovery in September 1846.

Little is known about this mysterious planet, which is about 4,4-billion kilometres from Earth. It was mathematically predicted before it was first telescopically observed on 24 September 1846. Astronomer Johann Gottfried Galle and his assistant Heinrich Louis d'Arrest used French mathematician, Urbain Le Verrier's calculations to locate the planet. It was found to be within a single degree of where Le Verrier had predicted it would be and, co-incidentally, was the first planet to have been discovered deliberately.

Its position was worked out because astronomers had mapped the orbit of Uranus and detected irregularities in its path that could only be explained if the gravity of a further, separate and unknown planet was disturbing its path around the Sun. This triggered the hunt for an eighth planet.

British scientist, John Couch Adams, had been doing similar work and produced similar results. Many people, however, claim that it was not Galle who first documented the planet and point to Gallileo for evidence of the discovery. He produced a drawing with an object labelled as a 'fixed star', which was the first telescopic drawing of Neptune.

According to planetary scientist, Heidi Hammel, of the Association of Universities for Research in Astronomy (Aura), Neptune is a frozen lump of gases with methane clouds and huge storms, which are seen as dark spots. Apart from that, little is known about Neptune as it has only been photographed once when a Voyager 2 mission passed by.

Seasons on Neptune last for about 40 Earth years and only Neptune's spring and early summer have been documented. However, Dr Hammel says that every time researchers look at the planet they discover something new about it.

She says that storms appear to form and dissipate more quickly than originally thought, but she is hoping for a breakthrough on understanding the planet when the NASA launches its Neptune Orbiter mission in 2016.

Is Earth just a ball of cosmic dust?

Cosmic dust caused by the violent explosion of a star 25 years ago exists in such large quantities that it would be sufficient to form at least 200 000 planets the size of Earth, according to data coming from the European Space Agency's powerful Herschel space observatory.

Mikako Matsuura, an astronomer at the University College of London, says that the supernova occurred in 1987 in a small galaxy known as the Large Magellanic Cloud about 160 000 light-years away when an aging star's core collapsed creating a violent explosion that was visible to the naked eye from Earth.

Light from the supernova showed a giant ring of material almost 10-million kilometres long. Herschel, which went into orbit in 2009, was able to detect that very cold dust particles existed in the ring with the dust at the centre of the ring at a temperature of about minus 215°C.

By studying the dust, using Herschel and other devices, scientists are hoping to better understand how galaxies, including the Milky Way, are formed and Dr Matsuura says that it is known that planets are formed from interstellar dust.

Paul Goldsmith, head of the NASA Herschel Project scientists, says that cosmic dust is made up of various elements including carbon, oxygen, iron and other atoms that are heavier than hydrogen and helium.

For decades astronomers have wondered how the huge fields of cosmic dust came about in the early universe but the new evidence from NASA's Herschel observations are the best evidence so far that exploding supernovae actually create the dust that can be seen all over the universe.

Goldsmith says that the Earth is almost entirely created from the material that once existed inside a star.

Meanwhile, a new supernova, classified as 1987A, brightened in recent months and scientists have now found that the brightening was caused by the enormous clouds of dust surrounding it and did not indicate that the supernova was about to explode.

Ambitious plans to employ 30 000 apprentices this year

by Paddy Hartdegen

Two major accords will see the number of skilled South Africans increasing dramatically. The accords have been signed by government, business and civil society groups and are part of a process aimed at turning out thousands of artisans and technicians in South Africa and improving the level of skills at many state schools.

The accords were signed by Business Unity South Africa's (BUSA) president, Futhi Mtoba, Congress of South African Trade Union's general secretary, Zwelinzima Vavi, and various government ministers.

Some businesses have agreed to impose a voluntary skills levy of between 4% and 8% of their companies' payroll to contribute an additional R1,7-billion to the training coffers. The money will be used for a number of training initiatives throughout South Africa.

In terms of current legislation, all businesses in South Africa must contribute one percent of the payroll to the National Skills Fund but the voluntary contribution of between 4% and 8% will see this fund increase to almost R6-billion.

When the voluntary skills levy is combined with the National Skills Fund of R4-billion, South Africa will have considerable sums to invest in training. Higher Education Minister Blade Nzimande has outlined how his department plans to spend the extra R1,7-billion that has been pledged by business.

The two accords are the National Skills Accord and the Accord on Basic Education and Partnerships with Schools. Both agreements are aimed at providing skills to young people and are a key part of Minister Ebrahim Patel's New Growth Path policy document for the country.

Nzimande says that while his department has not spent large amounts of money in the past, there are plans in place to remedy the situation.

As part of the National Skills Accord, businesses have pledged to

increase the training of new artisans to levels that are above their immediate needs and have agreed to make 12 000 placements for internships for students who will undertake further education and training programmes. It will also create 5 000 internships for third-year students who are currently studying at universities of technology.

In terms of the skills accords, employers in collaboration with the Sector Education and Training Authorities (SETA) will implement the plans and have undertaken to place 30 000 artisans in training this year.

Government has said that it will develop targets for internships in the public sector and has committed itself to enrolling 20 000 people as apprentices and learners by 2014.

BUSA's Mthoba said that the contribution from business would amount to about 10% of the total budget of the Department of Basic Education.

She added that South African companies had been contributing to training at all levels since "time immemorial" and would continue to do so. Business groups have agreed to 'adopt-a-school' so that individual businesses can form groups and work collectively with trade union representatives to boost the performance of poorly-performing schools in the country.

They would assist these schools to develop proper governance procedures, improve standards of teaching, implement basic discipline – for teachers and students – and ensure there were adequate supplies of essentials including stationery and text books.

The initial target was to adopt between 100 and 200 schools within the first year.

Nzimande said it would be impossible for his department to spend R6-billion in one year but that plans were underway to ensure that under-spending was cut to a minimum this year and that better planning was implemented for the years ahead.

Earlier this year, Sean Archer, a research associate in economics at the University of Cape Town, warned that the New Growth Path should be treated with caution since the competence of government in tertiary graduate and technical skills production was not supported by history.

In a paper produced for the Southern Africa Labour Development and Research Unit, Archer said governments could not determine the optimum mix of graduate output without resorting to market signals and to the collaboration of employers.

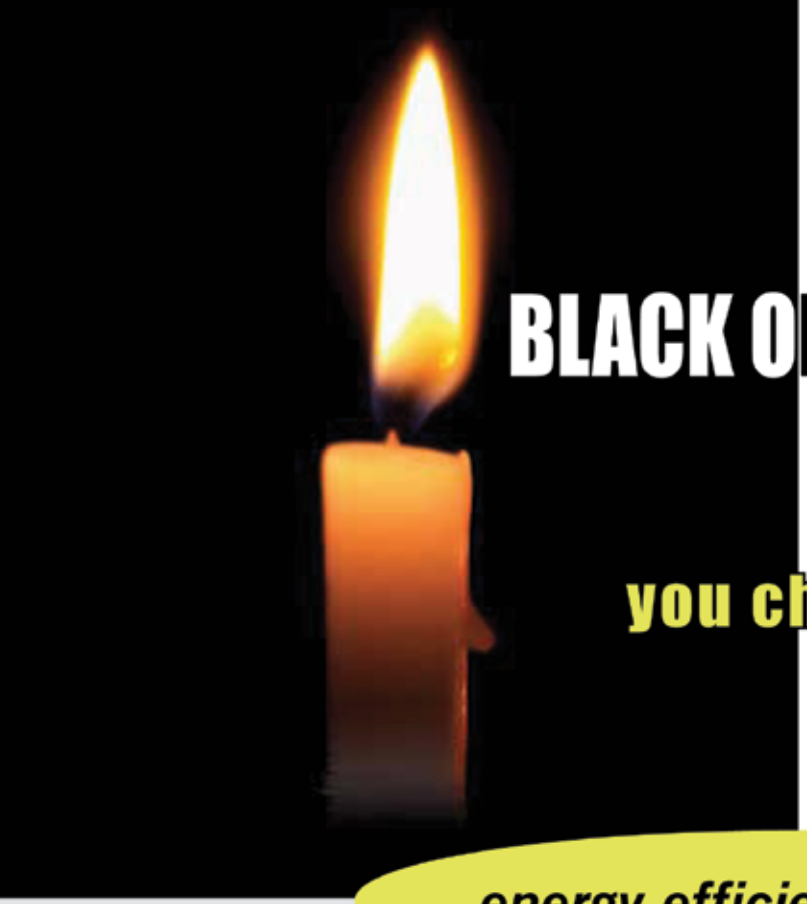
He pointed out that government could not force private employers to train skilled workers if such an investment was judged to be unprofitable or did not lead to the full recovery of costs for the companies involved.

He said that it was certainly true that the government could train workers within its own departments and could impose rules on state-owned enterprises to acquire skills and increase training levels. In terms of the New Growth Path, the state sets out to actively train large numbers of workers as part of a social goal to raise living standards, create jobs and sustain economic growth.

He said this was unlikely to be achieved unless policies were in place for skills training and warned that ownership of a skill meant it was a mobile asset. This meant that the investing employer – whether state or a private company – would have difficulty in ensuring that the newly-skilled worker stayed with the company for a minimum period, allowing the training investment to be recouped.

Archer pointed out that while the government was enthusiastic about planning, the information that influenced decision-making in the workplace was often sketchy. He said that initiatives from government such as the Sector Skills Plans or the Joint Initiative for Priority Skills Acquisition had done little to boost the volume of skills and played little or no role in resource allocation.

He said that, ideally, employers of skills should start to act collectively to prevent trained workers from being poached. He said that such a system had been implemented in Germany and had worked well there, while in France the government intervened to pass legislation that prevented poaching of skills between different organisations.



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$1,3-billion in food production wasted each year

Throughout Africa, huge amounts of food that have already been harvested are going missing or are rotting because of the poor state of infrastructure that prevents farmers from getting their products to market on time.

A report by the World Bank, entitled 'Missing Food: The case of post-harvest grain losses in sub-Saharan Africa', points out that crop production accounts for roughly 70% of typical income for farmers on the continent with grain crops accounting for about 37% of that, giving a recorded production of 112-million tons of grains a year.

Most of the grains are produced and consumed by small farming households. However, the worrying fact that emerges from the report is that significant volumes of grain are being lost after the harvest, aggravating hunger and resulting in expensive wastage of fertilisers, water resources and human labour.

The report says that the technical causes of crop losses are harvesting methods, poor handling procedures, drying methods and lack of proper storage. To make matters worse, grains are often stored in filthy conditions and become contaminated or are consumed by rats, birds and other pests.

From a governance perspective, the World Bank says that the sales infrastructure in most countries in Africa is poor and there are limited and prohibitive marketing and distribution policies and practices. It says that many African markets do not have mechanisms for dealing with the cash-flow needs of farmers and grain stocks are mismanaged.

Losses in eastern and southern Africa are estimated at about $1,6-billion a year; equivalent to about 13,5% of total grain production. The value of post-harvest grain losses in sub-Saharan Africa amounts to $4-billion a year of a total value of $27-billion for the whole sub-continent.

If these losses could be cut by just one percent a further $40-million would be injected into the pockets of farmers. Moreover, the annual value lost amounts to the total value of food aid provided to countries in sub-Saharan Africa and equates to the annual value of cereal imports.

The World Bank claims that these losses could be prevented by improving storage and handling facilities, using sealed bags for grains, erecting metallic silos for small farmers and by improving the technical capabilities of tinsmiths in Africa.

It recommends the establishment of innovative institutional arrangements and improved methods of operation at markets throughout the region. There are few success stories in Africa when it comes to traditional grains such as maize, sorghum and millet as many of the technologies that have been tried are not financially sustainable; provide few, if any, economic incentives; and are not accepted by the farmers themselves.

The report says that the farming communities generally tolerate post-harvest losses of grains because there is no economic incentive to reduce them. This is compounded by the fact that there is minimal mechanisation of farming methods, poor access to finance, inadequate electricity and a lack of market opportunities.

Several key trends are reversing this situation in Africa as urbanisation levels increase and more affluent middle class groups start to emerge. Changing consumer preference – for instance wanting milled maize – has contributed to changing demands and has also seen an increase in the preference among many consumers for wheat- and rice-based products over traditional grains.

The World Bank says that the donor community has not recognised that it is important for them to focus on 'systemic interventions' that will improve the efficiency of the supply chain in specific African countries rather than providing a single-point intervention as they have done in the past.

The private sector forms an essential part of the process of reducing post-harvest losses and should become involved in the provision of roads, electricity, and other essential infrastructure so that more modern farming methods and technologies can be applied in sub-Saharan Africa. It could also assist with technical training for basic forms of storage and hygiene and then help to improve the entrepreneurial skills of household farmers.

With regard to direct financial support to farmers, the World Bank says that this can be made but should be done with the stipulation that such interventions are driven by demand and are appropriate to the needs of the people. It says that any direct financial interventions should reduce the level of food aid provided to a specific country and that any intervention in the farming sector should focus on increasing the incomes of farmers themselves and should promote greater levels of food security for Africa.

The World Bank says that, increasingly, donor organisations want to know that the money they provide is being used to reduce losses and increase the sustainability of farms. It says that development practitioners, national policy-makers and other professionals and analysts need to start thinking in terms of optimising post-harvest systems with food security and income enhancement as their primary objectives.

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JOJEN SUPPLIES

Westinghouse still waiting for contract

Steam generators used at the Koeberg nuclear facility need to be replaced and upgraded at a cost of almost $250-million and apparently Public Enterprises Minister Malusi Gigaba has not yet approved the project.

Gigaba said that pressure was being put on him to sign the agreements as Eskom executives only have the authority to sign contracts worth up to R300-million. Gigaba is believed to be unhappy with the fact that most of the work has been awarded to Westinghouse rather than to its French competitor Areva, which apparently signed letters of intent with Eskom when President Jacob Zuma visited the country in March.

Eskom called for three separate tenders for the work that needs to be done at Koeberg. One was for the design and fabrication work, valued at $150-million, and another was for installation, valued at about $50-million. The third tender was for increasing efficiency at the plant and was valued at between $30-million and $40-million. Westinghouse was awarded the main design and fabrication work and Areva got the contract for improving efficiency by between 3% and 5% at the facility. It has also been shortlisted for the installation work that must be done there. Eskom has apparently signed the contract with Westinghouse but Gigaba has not approved the final deal and so work has yet to start on the urgently needed steam generators.

Some commentators suggest that because Westinghouse decided to pull out of the now defunct Pebble-Bed Modular Reactor project being pioneered in South Africa they were out of favour with the government.

Areva already has a substantial footprint in South Africa and is actively lobbying the South African authorities to get the deal for the country's second nuclear plant.

Eskom maintains that it followed the 'governance processes' required in terms of the legislation.

Skills shortage plagues Eskom, Transnet

Eskom has admitted that it has been unable to recruit enough people with specialised skills to complete the two coal-fired power stations currently under construction.

Dan Morokane, chief operating officer at the utility told Parliament's portfolio committee that it could train only about 600 of the 1 500 welders needed on site.

Without sufficient welders to work on the project, work at Medupi and Kusile power stations could be delayed.

Moreover, between 25% and 30% of the welders currently working on South Africa's existing electricity plants are foreigners and Eskom says that in order to meet the construction deadline for the new plants it will be necessary to employ about 75% of the welders from other countries.

In a separate submission to the portfolio committee, Transnet's chief executive, Brian Molefe, said that the organisation currently needs more than R400-million for its skills training and building programme.

He said that most of Transnet's labour force comprised young people between the ages of 25 and 35 and that there were very few workers aged between 39 and 45 who could take over the reins from senior management in the next few years.

Molefe said that the skills shortage at Transnet could be attributed to the fact that younger workers had not received the necessary skills training.

His announcements come at a time when the Passenger Rail Agency of South Africa (Prasa) has already issued a strong warning that most of its 8 600 commuter coaches and 2 000 Shosholoza Meyl locomotives would need to be replaced.

The agency said that the trains in use today had been built between 1958 and 1985 and that many of them were too old to be refurbished and would have to be scrapped.

The government has set aside R97-billion for new locomotives that are expected to start operating from 2015. Prasa estimates that it will need to raise R11-billion from investors over the next 18 years to allow it to build the new trains.

Transnet has been given a three-year contract to build 100 locomotives for the agency and is now looking to recruit and train designers, assemblers and other people involved in the manufacturing process.

CPD Overview

WATTnow, in conjunction with the SAIEE, launched this programme for engineers who need to meet their professional development commitment by acquiring Continuing Professional Development (CPD) credits in Category One (10). In terms of the renewal of registration requirements, all registered professional electrical engineers, technologists and technicians must earn CPD credits so that after five years they have acquired at least a total 25 CPD credits in all categories and at least five credits in Category One (1). The **WATTnow** CPD Programme provides a convenient and cost-effective way for engineers to acquire the Category One (1) CPD Credits. Failure to certify CPD credits could jeopardise renewal of their registration (CPD credits in the other Categories Two (2) and Three (3) must be acquired by other means – see the ECSA Rules on this aspect).

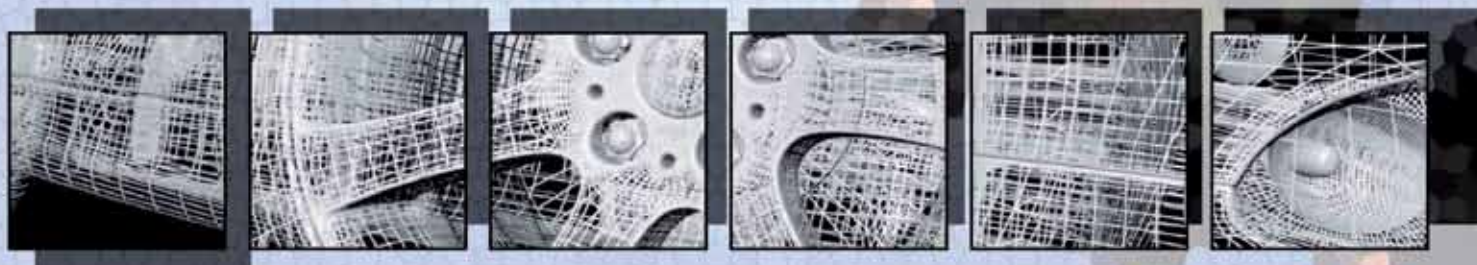
WATTnow publishes CPD articles in each issue that entitle subscribers to the scheme to claim for Category One (1) CPD credits. The programme requires engineers to respond to set questions posed on articles that are specially designed and validated to provide CPD credits. Engineers using the programme can accumulate 0.1 CPD credits per month if all the questions are answered correctly. **WATTnow** is published monthly so a total of 1.0 CPD credits can be acquired annually by this method. The articles and questions set are independently validated and reviewed by the SAIEE to which Validation numbers are allocated and should be recorded by subscribers.

Each year, **WATTnow** will supply a series of DVDs of lectures/conferences on topics that have been validated for CPD by the SAIEE. These DVDs can be ordered via the **WATTnow** website by subscribers to the CPD Programme.

Questions relating to the DVDs will be available on the **WATTnow** website and members of the programme can submit their answers online. Correctly answering the questions on the presentations in the DVD will entitle the subscriber to claim credits in Category One (1). These credits are in addition to the credits acquired by answering the questions to the CPD articles.

The SAIEE will provide subscribers with a certificate that records the exact number of credits gained for his or her records.

The **WATTnow** CPD Programme is based on a subscription service that will cost non-members of the SAIEE R2 400 a year while members of the Institute will pay an annual subscription fee of R1 000. The programme offers all members of the **WATTnow** CPD Programme a one-stop-shop to participate in and comply with the professional development criteria laid down by ECSA and ensure that all professional engineers can maintain their status without having to search around and pay significantly more to attend CPD courses or conferences in order to acquire sufficient credits for Category One (1) to meet the ECSA requirements.



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Electricity price hikes bite in July

Electricity prices in Johannesburg have risen by 27,7% from July while in Cape Town tariffs are up by 20%; in eThekwini, the rates climb by 19,8% and in Nelson Mandela Bay they are up by 22%.

Tariff increases for small, medium and large businesses range between 20% and 30% in the four metropolitan regions. The electricity increases in Johannesburg were confirmed when executive mayor, Parks Tau, unveiled his R33-billion budget for the city.

In terms of the budget, property rates will increase by 6,7%, water and sanitation charges will rise by 14% and refuse removal tariffs will climb by 6,7%.

Tau says the capital budget will focus on infrastructure projects within the city including the development of Alexandra Hostel and Baragwanath Central Precinct. Installation of pre-paid meters in the city will also be a major expenditure item this year along with upgrading the sewer and water infrastructure. The city's three major entities, City Power, Jo'burg Water and Pikitup receive R17,5-billion.

The announcement of the tariff increases came at a time when Eskom confirmed that it had reversed losses of up to R9,7-billion in the 2008/09 financial year. The power utility said it was "well capitalised" at the end of the financial year and that it had more than doubled last year's profits of R3,6-billion, making R8,4-billion this year.

The surplus was driven by higher tariffs for electricity implemented in April last year coupled with a consistently high demand for electricity during the winter months.

Electricity sales grew by a meagre 2,7% to 224 446GWh and pushed group revenue up by 28,6% to R91,4-billion. Peak demand this year has been forecast to reach 37 500MW, within Eskom's maximum generation capacity of 42 000MW.

The utility confirmed that it had signed power purchase agreements for 373MW of power from independent power producers including Sasol, Sappi, Ipsa and Tangent and had contracted municipal power suppliers in Johannesburg and Tshwane to deliver more power to its grid.

Referring to coal stocks, chief executive Brian Dames said that these were now at 41 days and were not expected to decline. He confirmed that the organisation was currently negotiating with its large customers on ways to reduce electricity usage.

He also confirmed that 71% of the R300-billion needed to fund its power expansion plans had been secured but added that the utility still needed to raise R230-billion and could only do so if it earned enough profits to ensure it could pay-off the debt.

Nuclear fuel vessel to dock in Cape Town

A shipment of nuclear fuel is due to land in Cape Town harbour in August or September and the National Nuclear Regulator has called for public comment ahead of granting a licence allowing the vessel carrying fuel to dock in Cape Town.

In terms of the National Nuclear Regulations Act anyone wishing to make representations to the regulator about safety, health or environmental issues should communicate with it directly. Until recently, importing of nuclear fuel did not require a licence.

In South Africa, nuclear fuel used to be manufactured at Pelindaba, west of Tshwane, but that facility was dismantled in 1995 and since then Koeberg has had to import its fuel, mainly from French company Areva, with a small amount being supplied by Westinghouse.

Once the vessel has docked in Cape Town, the nuclear fuel – packed in special casks – is off-loaded onto flat-bed trailers and taken by road to the nuclear plants. Refuelling of each reactor is required every 16 to 18 months and, in line with international practice, only about 30% of a reactor is refuelled at one time.

Unit One at Koeberg is scheduled to shut down for maintenance and refuelling in December this year. Last year one of the other units had to be shut down because a new fuelling rod had leaked. This matter is still being investigated.

Low and intermediate levels of nuclear waste from Koeberg are transported by road in steel and concrete containers to a remote disposal site at Vaalputs about 600km away in the Kalahari Desert.

The spent Uranium 235 rods are currently stored on high-density racks submerged in a reactor pool. The rods take about 100 000 years to decay and between 30 and 50 years to cool down enough to reach the boiling point of water.

Anyone wishing to write to the National Nuclear Regulator can do so at P O Box 4106 Centurion 0046.

Enrol for the WATTnow CPD programme

1. Monthly articles, published in **WATTnow** and validated by the SAIEE CPD provide credits for Category One (1) by answering appropriate questions.
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Inga may be resurrected if funding is found

The Democratic Republic of Congo has resurrected its plans to generate 40 000MW of electricity on the Congo River and staggered development of this project could make it easier for the country to raise the funds and secure stable clients, claims a report by the African Development Bank.

The DRC government estimates that it would cost about $22-billion to complete the Inga power complex, which would allow it to harness the electricity-generating potential of the world's second largest river by volume.

Work on the project, which includes $5,2-billion for the 5 000MW Inga Three power plant, has come to a halt because of continued political squabbles and a lack of available finance.

But the Africa Development Bank's vice-president for infrastructure, Bobby Pittman, says that it represents a "once-in-a-lifetime project", which the bank is keen to support.

The Inga complex would be capable of producing more power than China's Three Gorges dam and may even be able to supply the bulk of the power needs in Africa, where less than 15% of the population has ready access to stable sources of electrical power.

The New Partnership for Africa's Development (NEPAD) and South Africa utility company Eskom have both backed the plan and in 2008 the Africa Development Bank agreed to fund a $15,7-million feasibility study for the project. Pittman says that the research done for Inga is due to be completed by September.

Pittman says that the bank will now help authorities in the DRC to harness financing for Inga from private companies and other multilateral lenders but he could not say how much money the bank itself would provide for the project.

The African Development Bank invested $1,4-billion in energy-related projects on the continent and also put $1,9-billion into transport projects around Africa. It was established in 1964 and now has 53 member countries in Africa and 24 from other parts of the world. Nigeria is the biggest shareholder in the bank.

Poor infrastructure prompts hefty increases

Municipalities have blamed urgent infrastructure and maintenance projects for the increases in electricity tariffs that are higher than the National Electricity Regulator's recommendation of 20,38%.

City Power in Johannesburg says that the average age of its infrastructure has already reached 63% of its useful life and that it needs to refurbish the existing infrastructure and to build new infrastructure to support several major projects.

Nelson Mandela Bay has used the same justification saying that it requires at least R76-million for refurbishments and has a backlog in maintenance projects amounting to R122-million. Its capital replacement reserve has been depleted and the capital budget has been reduced from R264-million to R61-million for the financial year.

City spokesman Mvuleni Bukula says that the number of faults within the metropolitan area is increasing because the network cannot cope with demand and is in need of a major refurbishment.

In the Camdeboo region, which includes Nieu Bethesda, Graaff-Reinet and Aberdeen, network also needs to be upgraded along with the Sol Plaatje municipality, which experienced electricity losses of 16% because of its poor infrastructure.

Sol Plaatje has applied for a 24,98% tariff hike and has warned that if this is not granted by the regulator its expansion programme would be restricted and this would prevent the organisation from being able to repay its debts.

NERSA's electricity sub-committee chairman, Thembani Bukula, says that there are 184 registered municipalities in the country and that each one has to work within an inclining block tariff that is meant to help them provide affordable electricity with minimal energy losses.

In Mangaung, the metropolitan council has approved a 26,53% increase in its electricity charges as part of its first R3,6-billion budget. Other services in the metropolitan area will rise by between 10% and 12%.

Solar water heaters – sales remain low

The use of solar water heaters will have to be incorporated into various building codes if Eskom and the Department of Energy are to succeed in having a million units working by 2014.

This is the view of Frost & Sullivan analyst, Dominic Goncalves, who says that while Eskom's rebate programme has encouraged some homeowners to install solar heaters, there has not been a mass adoption of the technology.

He says that if the building codes stipulate that solar water heaters must be used on new housing projects the rate of installation throughout the country will improve.

Goncalves says that solar water heaters could stimulate the industrial sector in South Africa if a locally-based manufacturing facility were built in the country.

A new analysis, compiled by Frost & Sullivan and entitled 'South African Solar Water Heater Market', shows that sales of solar water heaters amounted to $41,6-million in 2009 and were expected to climb to almost $408-million by 2014.

Goncalves says this growth can be attributed to higher electricity prices that will lead to a reduction in the pay-back period for people installing these systems. He says that greater environmental awareness and high subsidisation levels for solar water heaters are expected to contribute to rapid growth.

He says that if South Africa were to succeed in installing a million solar water heaters, the electricity savings would amount to about 2 000MW, equivalent to the generating capacity of a medium-sized power station.

He says research has shown that about 18% of national electricity usage can be attributed to domestic water heaters and most of this usage occurrs at peak times when Eskom is struggling to meet the demand for electricity.

Goncalves says that poor quality products, a lack of skilled installations and some confusion among homeowners about which systems to buy has contributed to the slow conversion of traditional geysers to more cost-effective solar water heaters.

He concedes that the South African market is importing a number of low-quality products from Chinese manufacturers and that this has resulted in some suspicions among homeowners, who are particularly cautious about installing solar water heaters. The problems, Goncalves claims, are exacerbated by a lack of skills when it comes to installation.

Municipalities losing billions

Municipal losses for water and electricity distribution throughout the country cost councils about R3,5-billion and make up more than 30% of the R9,2-billion that was lost through misappropriation of municipal funds according to a report released by the Auditor-General, Terence Nombembe.

The report shows that R3,6-billion was written off to bad debts while under-expenditure resulted in R1,2-billion being returned to the National Treasury. He says the sharp increase in the current figures was a result of improved financial reporting by all municipalities in the country.

Nombembe says that 57 councils had improved their financial reporting, 162 were unchanged and 15 of them had regressed. However, he emphasises that the quality of financial reporting by municipalities is still unsatisfactory.

It comes at a time when the Auditor-General's office has called on city mayors to lead the drive to achieve a clean audit for all councils by 2014. Nombembe says that his office has set up a national partnership to improve the level of audits. He says that 84% of the municipalities did not comply with the regulatory requirements and for 65% of South Africa's councils the performance information was not meaningful or useful. More worryingly, 48% of councils reported performance information that was not supported by any evidence.

South African municipalities are facing serious challenges when it comes to the provision of electricity as they receive partial subsidies for new electricity connections and need to provide top-up funding from their own resources.

The Association of Municipal Electricity Undertakings (AMEU) outlined earlier this year that the delivery of adequate electricity services was severely hampered by non-technical losses (very often theft).

In June, figures released by South African Chamber of Commerce and Industry reported a decrease in copper cable theft for May when cables worth R16,63-million were stolen. In April this year cables worth R20,53-million were taken. Also in June, the National Prosecuting Authority confirmed that it had convicted two people in the Pietermaritzburg Regional Court for the theft of copper cable from municipal stores.

Confusing figures are published by the South African Department of Trade and Industry and published in the Chamber's Copper Barometer. It says that exports of waste and scrap copper from South Africa amounted to R350 000-million (an enormous figure if it is correct) at a time when the international copper price ranges between $9 500 and $10 000 a ton.

SAEE invites bursary applications

Bursary applications for the 2012 academic year are now open and the SAEE invites applications from students in their 2nd or 3rd year of study in the Engineering, Built Environment and Environmental fields of study, that do not have any existing financial assistance. The closing date for applications is 30 September 2011. Successful students will be invited to the SAEE Annual Banquet and Awards Evening and opening ceremony for the Energy Efficiency @ Work Convention and Exhibition on 16 November 2011 at Emperors Palace, Gauteng, to receive the bursaries.

The bursaries are funded by the SAEE's Mining and Industrial Energy Optimisation (MIEO) chapter and are granted to deserving candidates who show a natural enthusiasm towards making a difference to the environment and the energy security of the country.

The SAEE is in the business of optimising energy, which is a vital element in achieving successful sustainable energy supply in South Africa. Prof LJ Grobler of the North-West University and President of the SAEE, says, "The SAEE is actively involved in initiatives to secure the local energy future and to conserve the environment through promoting responsible economic growth. In order to ensure that these efforts are continued by the next generation, it is imperative to invest in today's youth as they will be building on the sustainable foundations that organisations, such as the SAEE, are laying now."

The bursaries last year were awarded to Simon Alger, a second-year BSc Mechanical Engineering student at the University of Cape Town and Lisa Mniki, also a second-year student, studying Town and Regional Planning at Durban University of Technology.

For more information on SAEE bursaries logon to www.saee.org.za or contact Danielle Badenhorst by e-mail at info@saee.org.za or by telephone on +27 18 293-1499.

WATTnow contributor wins Siemens Profile Award

WATTnow is delighted to announce that one of its regular contributors has been acknowledged in the 2010 Siemens Profile Awards for science journalism.

Peter Middleton of Crown Publications and editor of Mechanical Technology and African Fusion received a merit award in the Energy category for his article: Cycling and the lead acid battery, published in Mechanical Technology in December 2010.

"I am very pleased to have caught the judges' attention, particularly with this topic, which, although I find fascinating, is hardly a hotly debated topic among the science fraternity," says Middleton.

The Siemens Africa Profile Awards competition is an annual event which seeks to recognise journalists who excel in the fields of science and technology reporting. The awards ceremony this year took place in Doha, Qatar and honoured Science and Technology journalists working in print, online and broadcast media. South Africa's minister of Science and Technology, Naledi Pandor was the patron of this year's awards, which were themed around the Square Kilometre Array Project.

The winner of the Energy category was Francois Williams for his newspaper article, 'Skaliegas-ontwikkeling is propvol moontlikhede sowel as slaggate'' published in Sake24 and the overall winner of the competition was Elizabeth Fish for her television report, 'SKA telescope' aired by Carte Blanche.

Congratulations to all those journalists who were recognised for their entries.

All the winners seen here with Ms Naledi Pandor, Minister of Science and Technology (South Africa) and Patron of the Siemens African Profile Awards. Peter Middleton is on the extreme right of the picture.

Hydropower and the pioneers of independent power production

by Peter Middleton

NuPlanet is the developer of the Bethlehem Hydro Project, South Africa's first independent hydropower plant to be connected to the grid in 24 years. This award winning project has positioned the company as a benchmark independent power producer in the renewable energy sector and the undisputed market leader in small hydropower.

NuPlanet is a dedicated hydropower developer. PG Needham of NuPlanet explains, "While we supply renewable energy, at this point we don't get involved with energy efficiency and we have not yet done any solar or wind projects. Our interests lie solely in hydropower and we are presently positioned very well in this market.

"We estimate South Africa's small hydro resources to be in the region of 200MW, and until these projects are fully exploited and the market closes up, we intend to remain focused on the core strengths we have developed."

The 200MW estimation is based on identified pipeline feasibility studies totalling some 120MW of generating capacity and Needham suggests that a further 80MW of, as yet unidentified, opportunities are likely to arise. "Some studies suggest that 5 000MW is available, but these are desktop assessments based on total river flows and generic height variances across the whole of South Africa. Unfortunately, there are geographical limitations to hydro use, hence the lower number," he says.

NuPlanet sets out to exploit identified hydro resources with small hydro projects in the 2,0 to 50 MW range. "We first identify possibilities, when someone contacts us, through our own geographical studies or when a new opportunity arises," Needham explains. "From there we do an in-house assessment. This we call a pre-feasibility study to determine if it is worth putting our own money into the project – because we develop everything at our own risk. Based on the pre-feasibility report if, by our calculations, the project is feasible, we would move to develop it further."

That involves getting all of the required permits and licenses: water use and electricity generation licenses; land ownership; servitude rights; and EIAs for the power station and for the power distribution lines. "We would develop some conceptual or low-level designs and do some geotechnical investigations. Then, if we can get all of these in place, we package this up, add the financial models and a business plan, and take it to a bank. At the end of the day, securing finance is all about bankability," he suggests.

"If we have all the documents, permissions and engineering designs to legitimately build a power station, then we would get the money, appoint contractors, turbine and generator suppliers and start with the construction and the integration of the various engineering disciplines. We use the full EPCM process, we manage the whole process and we stay involved through every facet."

Not only does NuPlanet invest upfront, the company aims to remain one of the owning partners for the operating life of its projects. "We do take an initial developers fee, but we like to keep a majority share in our projects, along with a BEE partner and other investors. That way we have an operational interest in the well-being of the plant and, through Revolution Energy, take full responsibility for maintenance and operational efficiency.

Pioneering this approach – without the benefit of a REFIT tariff – NuPlanet successfully commissioned two hydropower plants on the Ash River for the Bethlehem Hydro Project; the 3,0MW Sol Plaatje Power Station in 2009; and the 4,0MW Merino Power Station in 2010. The generated power is sold to the Dihlabeng local municipality, and to Eskom. "This is time-of-use tariff, so there are three different tariffs during the day and two different sets of seasonal tariffs," he says. "This project has taught us a lot and we are now in a position to manage and operate much more efficiently."

The Ash River, says Needham, is an ideal hydro resource because it is not a naturally fed river. The water is delivered from the Lesotho Highlands project, so it has a continuous and constant flow release. In winter, when selling at the higher Eskom tariffs, the river flow is higher.

Plans are at an advanced stage for two more cascading projects on the Ash: "We signed a mandate with a commercial bank for two 4,1MW plants, one at Botterkloof and a second at Boston. For the Bethlehem project, only the DBSA was interested, but now the commercial banks are also keen to get involved," he says. "We will be using new turbine technology for these projects and a right-of-first-refusal agreement is in place for the supply of the complete water to wire package, which includes everything from the Eskom overhead connection all the way back to the turbine in the river."

But neither of these projects will be bankable without REFIT – or a privately agreed tariff level that is close to the original R0,98/kWh proposed in the 2009 REFIT draft. "We are hoping to be selling

to a single buyer under NERSA's REFIT programme. The tariff for hydropower was revised down to 68 cents during the latest review, but after the NERSA hearings, in which the whole sector participated, we are confident that the soon to be published final tariffs will accommodate our business," Needham predicts. "At 98 cents, we can make returns on our investments and we can develop some of the projects that were previously not feasible."

The REFIT tariff for hydropower is not as strongly linked to the generating technology as most other renewable energy options. "For solar or wind, for example, it is the cost of the technology that governs the total cost and the total returns that are possible. But because hydro has such a large site-based civil construction element, it is much more difficult to calculate a general tariff for all projects. Every installation is unique and the civil construction work component will usually account for 70% of total project costs."

Needham is optimistic about REFIT: "As soon as the programme is launched, a lot of private investors will be willing to develop projects. Our energy mix will improve and a lot of energy problems, particularly those in remote areas, will be solved," he says. "Generally projects like ours are symbiotic with Eskom. Our plants operate far away from Eskom power stations, so it is no longer necessary to send megawatts of power down hundreds of kilometres of transmission cables, with all of the associated transmission losses, to places like Bethlehem."

Even without REFIT, though, NuPlanet remains determined to make a success of small hydropower technology in South Africa. "It will take more time and more hard work, but we are confident that we can find private buyers. If we consider Eskom's proposed price increases over the next six years, the Megaflex tariff is likely to overtake the hydro Refit tariff in any case," Needham points out.

Looking beyond South Africa's borders, the company has also secured the rights for a 5,0MW installation on the wall of the Mtirikwi Dam near Masvingo in Zimbabwe. "We are in the pre-feasibility stage, have secured a generation license from the ZETDC and are currently looking for private buyers; sugar cane farmers, for example. The civils for this project are straightforward because it is already on the dam. We will have to build our own, 30km transmission line, though," he adds. Called Great Zimbabwe Hydro, the project is being developed in partnership with a Zimbabwe counterpart, MOL Power,

"The whole of Africa has electricity shortage issues and no country, including South Africa, has a surplus. So we are confident that the hydro market across Africa will grow. The existing hydropower projects were all built many years back and the current difficulties are more about poor maintenance and age than a reflection on the technology itself. All rivers are seasonal to some extent, and some projects might need backup for a few months a year, but for most of the time, hydro is an excellent solution for Africa," Needham concludes.

The Kaplan-type turbine used for the Sol Plaatje and Merino installations.

The Sol Plaatje hydropower station is located on the right bank of the Sol Plaatje dam. A new intake was constructed within the non-overspill flank and the power station was located immediately downstream of the intake.

Bethlehem Hydro's Sol Plaatje power station.

Renewable Energy : Photovoltaics

On Monday, June 27 at a meeting held at the University of the Witwatersrand, Dr Miroslav Begovic delivered his lecture on Photovoltaics. The SAIEE was well represented by 74 members; led by President Tshabalala of the Institute. Dr Begovic was accompanied and introduced by the Technical Chair for the South African Chapter of IEEE Power and Energy Society, Professor RG Harley.

The School of Electrical and Computer Engineering at Georgia Institute of Technology, Atlanta, USA has an advanced research programme into renewable energy sources and applications with particular reference to photovoltaic technology. Photovoltaic's (PV) technology converts light directly to electricity via solar cells, solid-state semiconductor devices free of moving parts, costly fuel requirements, and harmful emissions.

In the presentation, the status and basic features of PV technology were presented along with an outlook for its wider implementation in the near future. Recent advances and trends were discussed from engineering and economic perspectives.

For the Centennial Olympic Games in 1996 in Atlanta, Dr Begovic designed and presented, as an example, the 340kW photovoltaic system on the roof of the Aquatic Centre at Georgia Tech. In 1996, it was the largest roof-mounted PV system in the world.

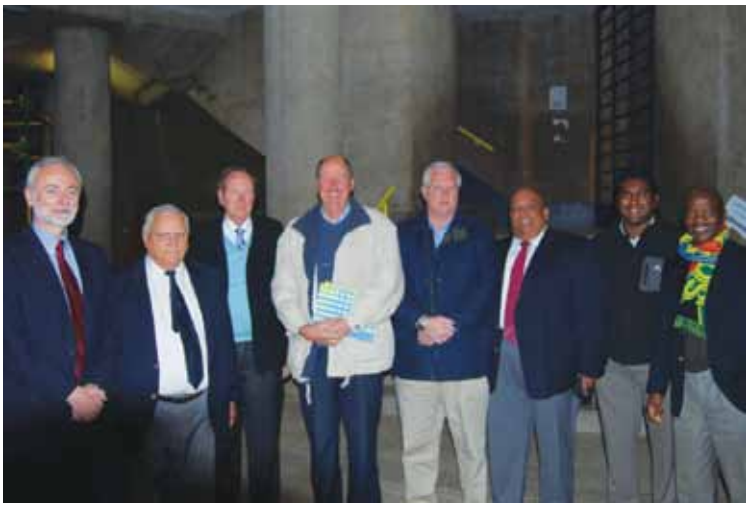
Solar-electric technology is extremely modular, allowing it to be quickly deployed at or near the point of consumption, minimising transmission losses and even providing electricity in regions that lack centralised power stations and their requisite distribution systems. This modularity makes PV attractive in industrialised and developing nations alike.

Furthermore, the cleanliness and environmental friendliness of PV make it an attractive technology for meeting the challenges of global electricity demand growth while simultaneously satisfying requirements for reduced emissions.

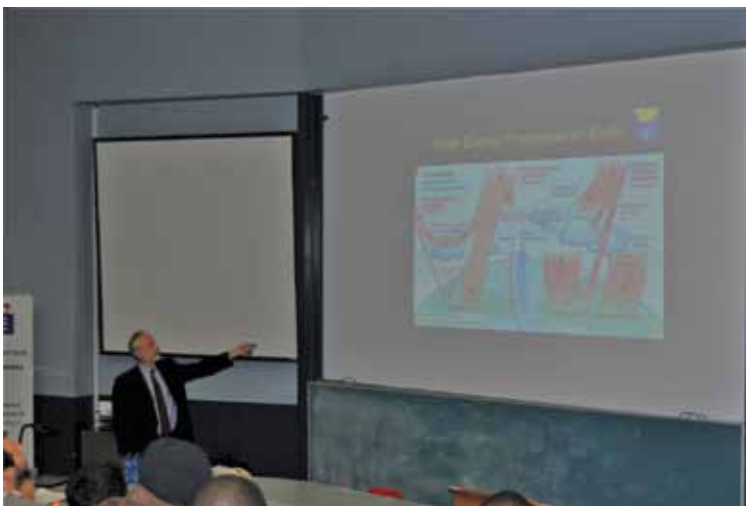
President Tshabalala moved the vote of thanks and the Institute's appreciation for a topic of current interest to members.

A joint meeting hosted by IEEE PES, SAIEE and the University of the Witwatersrand.

Left to right: Mr Dries Wolmarans, Dr Miroslav Begovi, Dr Pat Naidoo and Prof Ronald Harley.



Left to right: Miroslav Begovi, Ronald Harley, Dries Wolmarans, Viv Crone, Ian McKechnie, Pat Naidoo, Thavi Govender and Andries Tshabalala.



Dr Begovi delivering his presentation to the attendees.

Continuing Professional Development

Electromagnetism course in Bloemfontein

A two day long course on electromagnetism and transformers was held in Bloemfontein on the 14th and-15th of June.

The course was presented by SAIEE 2009 Engineer of the Year, Viv Cohen, at the President hotel in Naval Hill. Many attendees travelled from the Western Cape and KwaZulu-Natal to join the Bloemfontein contingent.

The presentation was well received and enjoyed by all those who attended. Each delegate received two CPD credits.

Writing technical documents

The Technical Report writing course presented by Malcolm Haffner took place at the Dowerglen Corporate Conference Centre on the 8th and 9th of June. The popular course was fully booked and attended by engineers wanting to improve the quality of their reports, and promote effective communication in the workplace. The delegates who attended the course were awarded two CPD credits.

This picture shows a practical exercise whereby the class participants are clustered into groups and handed the task of building an item by following the written instructions from a different group, which designed the object. The result can be amusing but does strongly emphasise the importance of effective communication through technical writing.

Finance Essentials for engineers

The Finance Essentials course presented by Tony Lydall on May 25 and 26 proved to be more popular than expected, prompting the SAIEE to hold an unexpected course the following week to accommodate the large number of people who were unable to book on the first course. Both courses were fully booked.

The course was targeted at Engineers, Managers, Supervisors, Team Leaders, administration and support staff. The attending delegates were awarded two CPD credits for the two day course. The course outline touched on budgeting, exploring the ground rules of finance, using financial statements, evaluating performance and making investment decisions.

Senior vice president Paul van Niekerk with course presenter, Tony Lydall. Paul felt it would be a good idea to attend the course and brush up on his financial knowledge as he would be chairing the finance committee in 2012.

EMI – EMC - A Faraday Legacy

On Monday 11 July 2011 Dr Prasad Kodali gave a presentation on 'EMI-EMC: A Faraday Legacy' to members of the SAIEE and IEEE at the University of the Witwatersrand. Concerns about electromagnetic interference are as old as the first practical realisation of Faraday's findings. Attention to such concerns, and the need to address them successfully, continues to be important even today. In this lecture, after a brief historical review, ramifications of electromagnetic interference in several systems and electrical circuits were discussed.

Left to right: Ian McKechnie – SAIEE Past President, Prof Duncan Baker – IEEE and Dr Prasad Kodali – IEEE Life Fellow.

CPD COURSES

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LV VARIABLE FREQUENCY CONTROLS
JOHANNESBURG: 24-25 August 2011
Presented by Chris Conroy
Cost: R3565 (incl. VAT) 20% discount for active SAIEE members. 2 CPD credits

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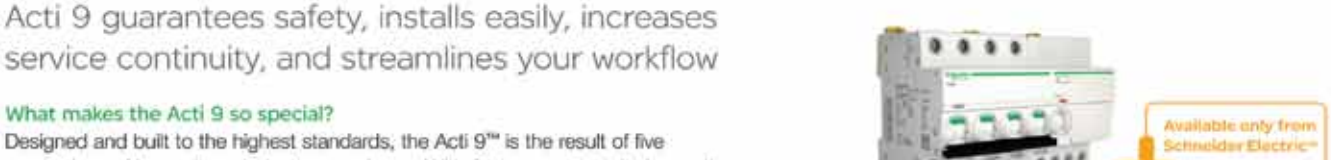

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