WATTnow

Be Enlightened

Tshabalala scores third win for Stellenbosch University

Microbes eat Gulf oil spill

South Africa could lead in second generation biofuels technology

Would you wear tea-shirts or tea-shoes?

Official Magazine of

SAIEE

August 2010

Jackboots aren't the answer – proper law enforcement is.

If the public servants in China staged a mass uprising, downed tools, stopped hospitals and schools from functioning and staged an outright rebellion against the government they would be detained, exiled and perhaps even shot. Maybe not on sight or in the public eye, but certainly in the confines of a labour camp somewhere.

That's what happens in Draconian societies and, fortunately, South Africa is not one of these.

If there were similar uprisings in African countries such as Nigeria, Angola or Mozambique, the police forces and the military forces in those countries would crack down on the strikers with a jackbooted approach reminiscent of the Gulags in Russia.

Fortunately this doesn't happen in South Africa either.

But the problem with this more liberalised and tolerant approach to the mass action strikes is that the workers themselves assume that because they are on strike, they are above the law. That belief is as dangerous and as wrong as any draconian measures enforced in less tolerant countries, isn't it?

Thousands of ordinary South Africans do sympathise with the plight of teachers and nurses who are working for a pittance and who are barely making enough money to feed their families.

But that wide-spread sympathy starts to go straight out of the window when Grade One pupils are intimated by union thugs determined to close down all schools, regardless of whether they have representation at the school or not.

The sympathy evaporates when toyi-toyi-ing idiots barge into an operating theatre and start damaging fragile equipment while they interrupt a surgical procedure.

That sympathy turns to anger when people start dying in hospital wards because knobkerrie-wielding union members prevent doctors and nurses from attending to the sick and dying patients in the wards.

And, like millions of other South Africans, that's where I find myself at the moment. I fully support the notion that workers have the right to withhold their labour. I also fully support the notion that there is a growing wage disparity that must be addressed and, if possible, resolved.

But I cannot support the notion that one group of people is above the law just because there are so many of them. What I cannot tolerate is the underlying implication that "we, the workers" can break the laws of this land without any fear of reprisals.

And I think that our government needs to take some decisive action to deal with the rebellious masses who can trash hospitals and schools, can prevent private citizens from doing as they choose or victimise school children in a misguided attempt to further a strike cause.

The thugs who are responsible for these actions need to be hauled before the courts and jailed for a period – albeit a short period while the strikes are underway – and sentenced to community service in those facilities that they disrupted too.

Part of me says (the angry part of me) that maybe the African approach is the right one to adopt: send in jackbooted military thugs to quell the public servants' strike. But that's an emotional response – and we all know that emotional responses are misguided.

In reality, I'd like to see our courts and our legal system taking immediate action against law-breakers because yes, South Africa is a democracy and it has labour legislation to protect the workers while they are on strike.

But that protection doesn't extend to breaking the law.

And what the strikers are doing right now is breaking the law. And South Africa's leaders must enforce the law – even if it causes tension between opposing factions such as the Congress of South African Trade Unions and the ruling parties.

Because the cold reality is that without the rule of law, South Africa is truly doomed.

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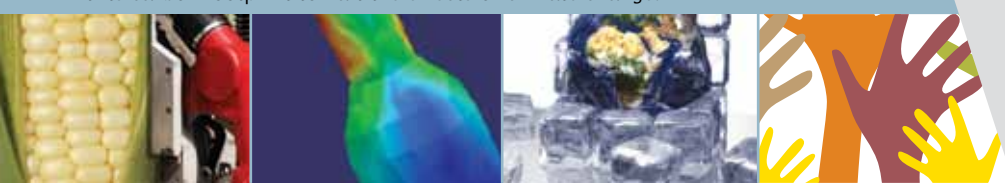

5> WATT'S GOING ON?

Scotland, Italy and Sweden to benefit from infusion of African ideas; Aquilla installs 60 kW solar concentrator; Stellenbosch just keeps on winning.

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INSIDE

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Driven by Powertech

Scotland, Italy and Sweden to benefit from infusion of African ideas

An Information Systems academic at the University of Cape Town has achieved recognition from a European Union programme whose roots go back to Erasmus Mundus, a Dutch humanist and the first intellectual to understand the power of the printed word.

Information systems adjunct Head of Department, Dr Kosheek Sewchurran has been named as one of 20 scholars worldwide to receive a sought-after Erasmus Mundus scholarship, which will enable him to engage with the top young minds studying strategic project management in Scotland, Italy and Sweden. The Dean of the Faculty of Commerce, Professor Don Ross, says: "I am delighted that the department of Information Systems, which is at the cutting edge of technology research in Africa, should achieve recognition in this way. It is also gratifying to be linked through this scholarship programme to the first intellectual in Europe who harnassed the power of the technology of the printing press to stimulate critical debate. This golden thread of using technology for the greater good is at the heart of what we are attempting to do at UCT".

Dr Sewchurran (38) was selected from a pool of more than 1 600 applicants to lecture at three top universities as part of the Erasmus Mundus Programme aimed at improving the quality of higher education by encouraging trans-national co-operation between universities.

The programme is named after the Dutch philosopher, Desiderius Erasmus of Rotterdam (1467–1536), who was the most famous and influential humanist of the Northern Renaissance, a man who rose from humble beginnings to become the leading intellectual figure of the early sixteenth century. He was a prolific writer and the first European intellectual to exploit the power of the printed word.

The Erasmus Mundus Programme is oriented towards globalising European education and the award to UCT is a reflection of the need in Europe for "an infusion of African ideas," according to Dr Sewchurran.

Selection is based on academic performance, research focus and credentials and researchers are attracted to the programme as it is a platform to engage with the young bright minds of future leaders.

Sewchurran says the attraction for him is to teach new ideas on project practice and competence, which he has published as a result of his PhD research. It is also a chance for him to interact with other leading academics in the Project Management space from elsewhere in the world.

He will spend three months over a two-year period at the Heriot-Watt University, Edinburgh, the Politecnico di Milano, in Milan, and at the Umea University in Sweden.

Aquila installs 60 kW solar concentrator

The Big 5 Aquila Private Game Reserve near Cape Town has installed a 60 kilowatt solar concentrator as the first step in the development of a 50 MW plant. The 60 kW facility is a Concentrator PhotoVoltaic (CPV) system, with panels that move to track the sun and will start producing power in September.

The new solar panel facility will be housed at the Aquila Rehabilitation & Conservation Centre (ARC) which is situated on a separate piece of land directly opposite the main entrance of the private game reserve. Aquila has invested over R1-million building a large outdoor sanctuary comprising several one hectare fenced camps where lions can live out the remainder of their lives. The lions, known as canned lions were rescued from certain death and put into the reserve.

"With many hours of abundant sunshine in the Cape Karoo, Aquila is a perfect site for the use of solar energy. I am proud to have initiated what I believe to be the ultimate responsible usage of land as a platform for sustainable, social upliftment, conservation and renewable energy projects, in one of South Africa's most impoverished towns," claims Aquila owner, Searl Derman.

The deal has been signed with Concentrix Solar, a leading German supplier of CPV systems and it is the company's first power facility in the country. Between Aquila and Concentrix there will also be a skills development programme to train over 200 local residents of Touws River in security, construction and maintenance of the solar plants. This will add to the ongoing skills development programmes in construction, tourism and game ranging fields at Aquila.

Derman has been committed to uplifting the town of Touws River ever since hearing about the withdrawal of the railway from the town in the 1980s. This left massive unemployment of approximately 97 percent of a town's 9 000 residents. Derman has been involved in several award winning social upliftment and conservation efforts that have sustained the town.

These include setting up a soup kitchen to provide about 12 000 meals a month, cleaning up the town and using recycled litter to generate money to pay school teachers. Derman sponsors the town's rugby, cricket and soccer teams and he has donated several thousand blankets to the poor and destitute people in the town.

Aquila, established in 1998, is just two hours from Cape Town.

Stellenbosch University just keeps on winning

The University of Stellenbosch took the top spot for the third time in a row with their Tshabalala Soccer Ball Shooting Machine. The design was done by four Stellenbosch Mechanical Engineering students: Mr Deetlefs, Mr T Mofokeng, Mr RS du Plessis and Mr AC Oelofse.

The overall aim of the PneuDrive Challenge competition is to feature design innova-tion in the field of mechatronics. Students engaged in the 2010 PneuDrive Challenge competition were instructed to design an application using SEW Eurodrive and Festo products with the theme for this year's competition being "motion in sport". The Stellenbosch team identified the training regimes of soccer teams as the greatest opportunity to design a "sporting solution" with meaning, which was additionally complemented by the excitement and enthusiasm created by the 2010 FIFA World Cup.

A possible shortcoming of many soccer training sessions could relate to goalkeeper and set-piece training. When goalkeeper training takes place, many players may be required to take kicks at goal (which limits their training time), and their incoming shots are, in effect , predictable (which contrasts with the reality of a soccer game). A machine designed by students from Stellenbosch University that can simulate set-piece training as well as generate random and unpredictable kicks on goal could help teams maximise the training time of out-field players and heighten the effectiveness of goalkeeper training. The user friendly application offers control of the system via a wireless console instead of a computer containing complicated software. This allows the control interface to seem like something "close to home" for a soccer coach. The report went further to back up the design with the relevant calculations, structural analysis and empirical data where applicable. Safety precautions were put in place and energy efficiency, costing and business viability were discussed in great detail. The amount of detail in the design drawings as well as the time and thought spent on the project plan were two of the things which particularly impressed the judges.

The winning team: Mr Deetlefs, Mr T Mofokeng, Mr RS du Plessis and Mr AC Oelofse – Mechatronic students at Stellenbosch University.

The team worked under the capable leadership of Professor Anton Basson who led the two previous Stellenbosch teams to victory. Professor Basson expressed his sur-prise at the winning announcement. "I am thrilled for the students and the university. The fact that the judges were impressed by the level of detail in the design is particularly encouraging. I always tell the students that the secret is in the detail. It takes a lot of extra time and effort to pay attention to the smaller things but it is always worth the end result" he adds.

The competition has now been won by Stellenbosch University two years in a row. "It is definitely a case of Stellenbosch having the winning recipe for the competition – a dedicated lecturer and the fact that the competition forms part of the syllabus which allows students more time to work on their designs", comments Norman Maleka, Electronics Manager for SEW Eurodrive and a member of the judging panel.

Judges were impressed by the level of entries received this year. Dale Oosthuizen, Technical Director for machine builders ABTECH, has been part of the judging panel for three years. "The entries get better every year. The level of creativity is always the most interesting aspect of the judging for me", comments Dale.

The judging panel included leaders in business such as:

Antonie le Roux, Project Engineer – Bateman

Dale Oosthuizen, Technical Director – Abtech Enterprises

Norman Maleka, Electronics Manager – SEW Eurodrive

Ken Nixon, SAIEE representative and Senior Lecturer (BSc(Eng) (Electrical), MSc, PhD (Wits), SMSAIEE, MIEEE)

Chris Oliver, Didactic Consultant – FESTO

The winning team receives an all expenses paid ten-day trip to Germany, membership to the SAIEE and R 100 000 worth of SEW Eurodrive and Festo equipment for their university.

Judging panel: Ken Nixon (Wits), Chris Oliver (Festo Didactic) Dale Oosthuizen (Abtech), Norman Maleka (SEW Eurodrive), Antonie le Roux (Bateman)

Billionaire wants more cash for alleged patent infringements

As if he hasn't already got more money than he knows what to do with (or perhaps he has it) Paul Allen, Microsoft's co-founder is suing Google, Apple, Facebook and eight other companies over patents that he claims he owns.

The 11 companies are all accused of violating four patents that cover fundamental web technologies that were apparently developed at Interval Research in the 1990s.

Allen owns Interval Licensing, which in turn owns the patents of Interval Research, a company that employed 110 of the world's leading scientists, physicists and engineers.

Allen claims the company helped to fund outside projects including work done by Google's founders, Sergey Brin and Lawrence Page.

There have been numerous issues of patents, many of which are still waiting to be settled, and Apple's major successes with its iPhone, iPad and range of computers has been attracting more and more law suits claiming that it has infringed some patent along the line.

Last year Apple was ordered to pay $19-million to Opti Inc for infringing a patent called Predictive snooping of cache memory for master-initiated accesses and describes a method to more efficiently transfer data between the central processing unit, the memory and other devices. The patent was issued to Opti in 2002.

In a separate case, HTC is suing Apple and Apple is suing HTC and so the patent roller-coaster goes around and around. Perhaps the most famous case of patent infringement was when Apple sued Microsoft for its Windows operating system claiming that it was a copy of the Apple user interface, which of course it was.

Apple lost the case because Windows is a software-driven user interface whereas Apple's user interface is encoded onto the chip. Do a Google search on Apple patent infringements and you will find 446 000 documents related to these terms.

It seems that there might well be a number of highly skilled, intelligent physicists, electronics experts and engineers locked in rooms throughout the world, dreaming up patents and filing them just in case, sometime in the future, someone has a similar idea and applies it.

McAfee sold to Intel for $7,7-billion

Chip manufacturer, Intel has bought the anti-virus software group McAfee for $7,7-billion in a bid to help the company address many of the hacking and virus attacks that have plagued computers in recent years. The deal is the biggest in Intel's history.

According to Paul Otellini, chief executive of Intel, the deal will allow the company to incorporate greater levels of security into computers, mobile phones and even cash registers.

He says that in the past, energy-efficient performance and multi-platform connectivity were defining computer requirements but, in future, security will join those two elements as the third pillar of what customers are demanding in a computing experience.

Otellini says that the combination of Intel's chip expertise and McAfee's knowledge of hacking and virus protection will provide greater levels of protection against cyber-security threats.

Intel has recently made several acquisitions aimed at helping it expand in the smartphone market, which is currently dominated by Britain's ARM Holdings. It comes amid a flurry of new acquisitions among other companies such as Hewlett-Packard buying Palm and Oracle's $7,4-billion acquisition of hardware group Sun Microsystems.

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Piracy is theft – but do Internet users care?

Music piracy is remarkably widespread throughout the world and there are literally millions of people who hunt down pirated copies of their favourite tunes and replay them via any one of many handheld devices or computers. However, Gary Locke, the US Commerce Secretary claims that it is "unadulterated theft" and should be dealt with accordingly.

He warned that digital piracy is now threatening America's economic competitiveness and he called on Internet Service Providers and copyright holders to work collaboratively to combat this piracy.

His comments are correct, but the major question for musicians, publishers and performers is not whether music piracy is right or wrong but how you combat it effectively.

According to Locke, the Commerce Department is now working on new policies for copyright protection and are trying to figure out a way to shut out the pirates while preserving the Internet as an avenue for commerce in the music industry and in other creative sectors.

Apple, through its iTune store is trying to reduce the price of music to such an extent that people no longer object to paying for it. Amazon, like iTunes has also introduced a system where it is possible to download individual tracks (rather than the whole album) and pay small fees (typically 99 US cents).

The approach, while innovative, has done little to stamp out piracy because people won't pay unless they have to.

Technology writer, Mike Masnick, a blogger, who writes for the Techdirt website in the US, criticises Locke, saying that statistics indicate the spending on music and music-related products has increased dramatically in the past few years and will continue to do so.

Some analysts say that the only way to minimise piracy is for service providers to charge a blanket fee for an Internet connection and then apportion part of that fee to pay royalties to a centralised fund that then distributes the funds on the basis of the downloads.

However, this concept has been largely discounted because of the difficulties of administering and controlling it and, more importantly, apportioning payments.

Yet another computer failure hits Goce's craft

The European Earth observation satellite has been struck by a second computer glitch and is unable to transmit any scientific data back to Earth. A processor fault forced operators to switch the satellite to its back-up computer system in February and now the back-up system seems to have failed as well.

The European Space Agency says it is confident that the computers will be able to function again and the Goce mission manager, Dr Rune Floberhagen says that there are "many ideas" on the table to make the satellite functional again.

Last year ESA lost the use of one of the instruments on its billion-Euro Heschel space telescope but computer engineers on Earth were able to rectify the hardware problem and bring it back online.

All the other systems on the Goce craft are apparently functioning normally, including the gradiometer that senses subtle difference in the pull of gravity from different sites on the Earth's surface.

The instrument's data-gathering functions have been suspended for the time being and the spacecraft has been repositioned to a higher orbit while computer engineers try to resolve the transmission problems.

The first problem, in February this year was caused by a chip failure and was apparently not related to breakdown of the communications link to the processor board on the second (or redundant) computer aboard the craft.

Engineers have tried the traditional remedy of restarting the computer but this has not resolved the problem, so the engineers are trying to get some functionality back into the original computer.

Floberhagen says that if the engineers have two half-working computers it may be possible to stitch them together and start transmitting again.

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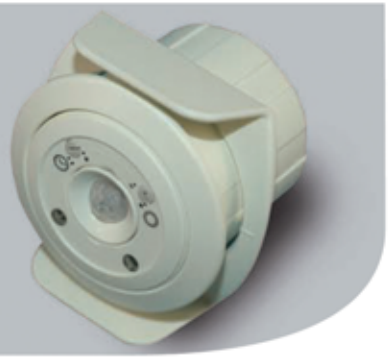

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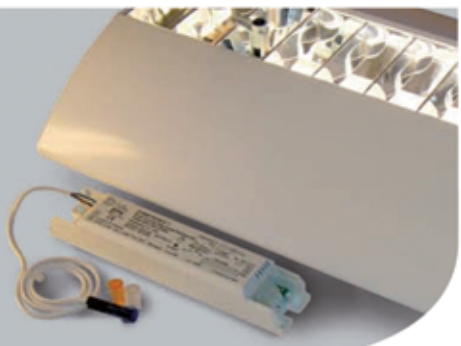

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Stellenbosch wins for the third time

The euphoria of the 2010 World Cup was quickly brought crashing back to ground as the public servants embarked on perhaps the biggest strike in South Africa's history amid threats from the Congress of South African Trade Unions – and a number of others as well – that they would support this mass action and bring the country to a standstill.

Hospitals, schools, clinics, certain emergency services and virtually all government departments came to a halt amid angry blockades that prevented those people who wanted to work getting in or out of the buildings.

Primary school children were sent back home or told to wear civilian clothes so as not to be conspicuous otherwise they might attract the attention of the unruly thugs.

So much for the unity the World Cup instilled. So much for the goodwill that offered the nation hope. It came crashing down in a matter of minutes and, in the first few weeks of the strike, the impact on workers' salaries alone was estimated at R300-million and climbing each day. Added to this were some other strange statistics that economists quickly found buried in their filing cabinets: that the wage bill now constituted 47 percent of the tax revenue collected by government and also constitutes about 30 percent of government's entire spending.

Is it really a bloated public service? It would certainly seem so.

And then, government spokesman Themba Maseko warned that the wage offer – increased to 7,5 percent, along with a housing allowance of R800 – will lead to increased borrowings and may even put the country's credit rating at risk.

He says the government will be forced to borrow money to pay wages and debt service costs and that the wage increase may force the government to reduce its investment spending and that, too, will have a huge impact on South Africa's economic growth.

Standard & Poor's Konrad Reuss says there is already a negative outlook on the South African rating, which is due to be revised after the medium-term budget policy statement in October.

South Africa compares badly with other emerging economies such as China and India because the labour rates in this country are so high and the productivity levels well below those of its competitors on world markets.

In China, the average monthly wage for a city worker is 1 783 yuan (R1 945) and a labourer might earn about one third of that with free food and dormitory accommodation thrown in. This compares with Stats SA's the average monthly salary, including overtime and benefits of R6 400 for South African workers.

However, government workers are apparently not interested in these statistics (or the sustainability of the South African economy it would seem) and have called for further disruptions to bring the country to a standstill.

The Western Cape branch of the South African Democratic Teachers' Union condemned the government offer as being an "insult" and claimed that members would accept nothing less than 8,6 percent and R1 000 housing allowance.

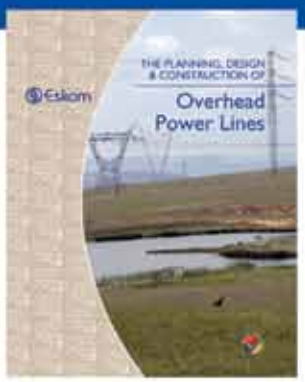
Unions have 21 days to accept the government's offer, otherwise the state will revert to its initial offer of 5,3 percent and a R620 monthly housing allowance.

The South African Municipal Workers Union is planning sympathy strikes with the public service workers and even the Congress of South African Trade Unions may still bring its members out on strike in sympathy with them. And, the Police and Prisons Civil Rights Union (Popcru) has appealed against an interdict granted by the Labour Court to prevent them from joining the public services strike.

Meanwhile, President Jacob Zuma has instructed his ministers to negotiate with the unions to bring the crippling strike to an end prompting Cosatu to issue a public statement 'condemning the personal attacks by striking workers against the president'.

Cosatu spokesman, Patrick Craven went on to say that the federation "apologises to him and his family and all others to whom insults were directed for the hurt that these have caused."

Craven didn't bother apologising to the people of South Africa, though, as it is the country as a whole that deserves an apology rather than the president, although he did condemn the acts of violence and did call for restraint from striking workers. Of course, not all members of the Federation are on strike so Craven is referring to the public utterances of Cosatu members rather than the actions of the union members, but be that as it may. Surprisingly, bond, stock and rand trading on international markets have largely been unaffected by the strike action but market analysts expect that this might change



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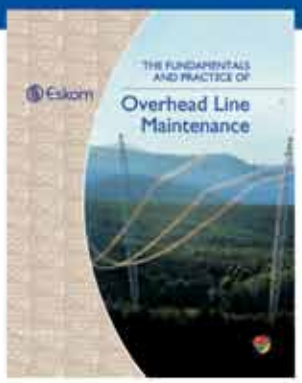

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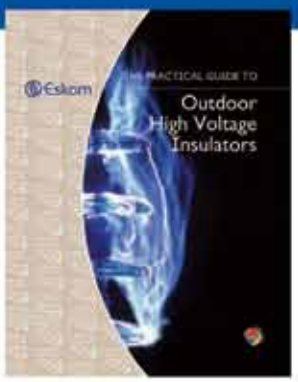

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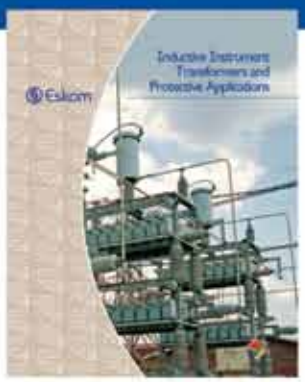

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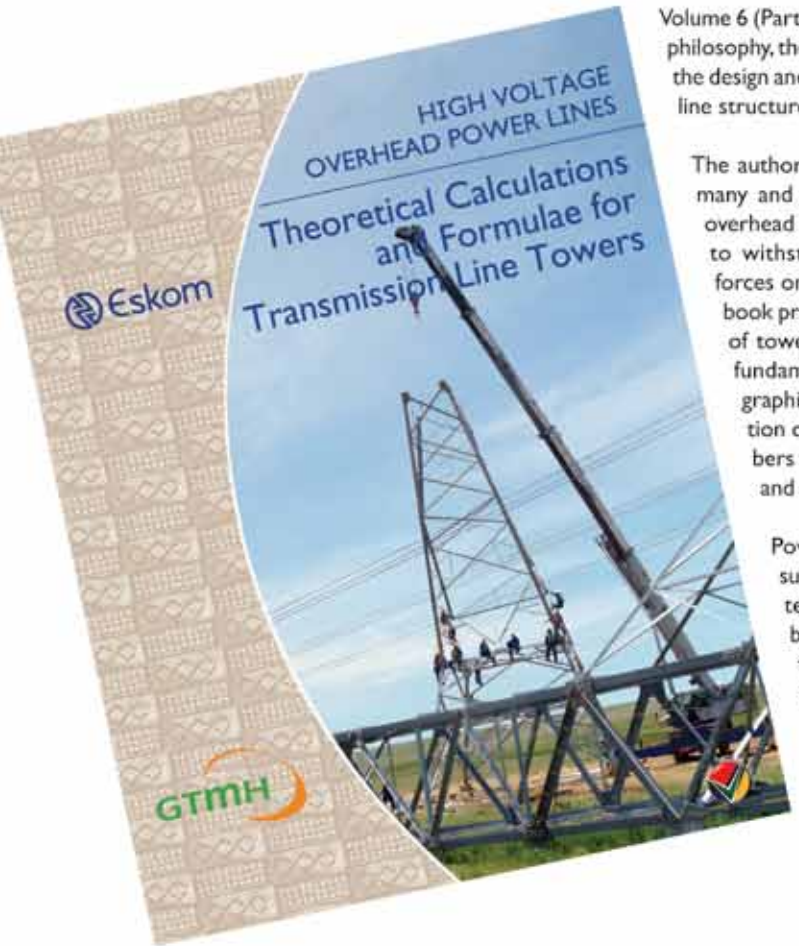
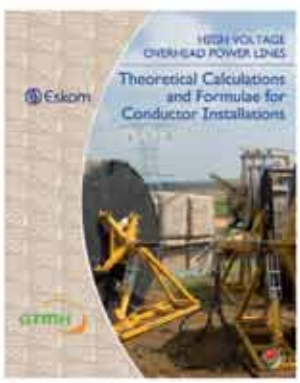


Volume 6 (Part 2) takes the reader through the philosophy, theory, principles and practices of the design and fabrication of overhead power line structures.

The author begins with an analysis of the many and varied mechanical forces that overhead power line towers are required to withstand. Once the nature of the forces on the towers is understood, the book proceeds to discuss the geometry of towers. It moves on to discuss the fundamentals of force diagrams and graphical techniques for the calculation of the forces in the tower members and introduces finite elements and computer methods.

Power line towers are routinely subjected to full scale mechanical testing and the book concludes by describing the procedures followed at major test stations around the world.

Volume 5: Theory, Design, Maintenance and Life Management of Power Transformers



Volume 6: High Voltage Overhead Power Lines: Theoretical Calculations and Formulae of Conductor Installations

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if there is more widespread and more protracted strike action from public service workers and the rest of Cosatu members.

The real impact of the widespread strike action will be on government investment and the impact it will have on the budget deficit. Any deal acceptable to the unions will probably amount to between one and two percent of state spending, placing an enormous additional burden on government coffers.

The real cost to the economy in terms of lost productivity is difficult to quantify but some economists believe that it could amount to about R1-billion a day in the public sector alone. Then when the impact of other strikes is added to that figure, it's even higher.

And that excludes the underlying additional costs of deploying South African National Defence Force personnel to various centres around the country. In Gauteng, SANDF medical personnel were sent to the Chris Hani Baragwanath Hospital, Natalspruit and Helen Joseph and in KwaZulu-Natal, medics were sent to the King Edward and Mahatma Ghandi Memorial hospitals to support medical functions at these provincial facilities.

Moreover, SANDF personnel were deployed to assist maintain security services at government facilities in Gauteng, Limpopo and KwaZulu-Natal and were placed on standby in the other provinces.

These costs obviously haven't yet been factored into the estimates.

Just as the threatened sympathy strike from all of Cosatu's nearly 2-million members can't be included either because that sympathy strike been put on hold (at the time of writing) while negotiations are underway.

But when the public servants stopped working throughout the country, the strike in the automotive sector was resolved when the Automobile Manufacturers Employers' Organisation (Ameo) reached an agreement with the National Union of Metalworkers of South Africa (Numsa) that provided an across-the-board increase of ten percent in 2010 and nine percent in 2011 and again in 2012.

That increase comes at a time when the current inflation rate is just 3,7 percent in August 2010, and represents a direct gain of 6,3 percent. Possibly buoyed by their success with Ameo, Numsa informed the Fuel Retailers' Association that its members working on forecourts around the country would go on strike as well, spreading some alarm among motorists who feared that South Africa could face protracted fuel shortages.

Numsa is demanding an increase in the hourly wage from R13 to R20, a rise of almost 50 percent. In fact, Reggie Sibiya, chief executive of the Fuel Retailers' Association says that with double-pay for Sunday work, increased night-shift allowances and a reduction of the working week from 45 hours to 40 hours the real impact on workers' wages will be equivalent to 89 percent against an inflation rate of 3,7 percent.

He says the demands from Numsa just cannot be met, particularly considering that in 2007 wages jumped by 68 percent to bring them into line with minimum-living-wage expectations.

Sibiya could not give an indication of how many Numsa members were employed on garage forecourts around the country.

Ahead of the strike among forecourt workers, Numsa also informed tyre manufacturers, Dunlop, Bridgestone and Continental, that workers in these factories would also down tools unless a 15 percent wage increase was implemented. The companies had offered 6,6 percent.

In a separate notification, Numsa served notice of a strike on the Retailers Motor Industry's members as well saying workers who are part of the union would also down tools indefinitely.

Not to be left out of the strike action, the National Union of Mineworkers called on its 2 300 members at Richards' Bay Minerals and Exxaro Sands to go out on strike after it failed to reach agreement with the two companies.

The 1 700 workers at Richards' Bay Minerals want a 10 percent across-the-board increase and the housing allowance to rise from R3 200 to R4 000 for employees on grades six to 10 while those in grades 11 to 13 are demanding housing allowances of R6 000, up from R5 500. At Exxaro Sands, 600 workers there want a wage increase of 14 percent. But that's not where the unhappy picture of unhappy workers ends. The South African Commercial, Catering and Allied Workers' Union says that it will bring its 25 000 members out on strike over a wage dispute with retailer Pick 'n Pay.

Pick 'n Pay says it hasn't received official notification of the strike but Saccawu claims that its preparations are advanced and the retailer will be notified soon. It's unlikely that other retailers will be able to avoid similar strike action given the apparent 'victories' in other sectors of the economy.

In an ironic twist, the Southern African Clothing and Textile Workers' Union, Sactwu) launched an urgent court application to prevent the Newcastle Chinese Chamber of Commerce from closing its member factories in the town.

The member companies have decided to close their factories indefinitely. Factories in Newcastle currently employ about 8 000 people and sustain about 40 000 people in the surrounding areas. According to the Chinese Chamber of Commerce spokesperson, Alex Liu, officials from Lesotho, Swaziland and Mozambique have been encouraging the Chinese companies to move to their country and he says this is a feasible option as the labour rates in those countries are considerably lower than those in South Africa.

Apparently Sactwu wants a minimum wage of R324 a week compared with the current rate of R200 a week, an increase of more than 50 percent as well.

South Africa could lead in second generation biofuels technology

With South Africa to be reliant on coal fired electricity for some time into the future, it is most likely the country will have to find other ways of reducing its carbon footprint. One of the main contenders remains biofuels, an option whose profile has fallen over the past couple of years.

However, a start-up company, Stellenbosch Biomass Technologies (SBMT), has set about reversing this situation with its plans to commercialise one of the world's most promising technologies for the production of cellulosic ethanol. Cellulosic ethanol is one of the forerunners in the production of second generation biofuels from non-food lignocellulosic (fibrous plant biomass) sources, including wood and agricultural residue such as sugar cane bagasse.

SBMT has an agreement with US company Mascoma Corporation, which gives SBMT the exclusive licence to use that group's technology in sub-Saharan Africa. Mascoma is rated as one of the top ten most innovative companies in the global bioenergy sector out of a total of some 1,400 companies. The reason the Mascoma technology has been offered to SBMT is that the department of microbiology at Stellenbosch University, where SBMT director and co-founder Professor Emile van Zyl holds a research chair, helped develop the technology. SBMT is expected to be based in Stellenbosch.

There has been a ten year academic relationship between Stellenbosch University and Dartmouth University in New Hampshire, USA, from where Mascoma sprang up. The microbiology behind the technology, which is protected by some 30 patents, was partly gestated in South Africa, while the process engineering evolved in the USA. The Mascoma technology offers the opportunity to take biofuels production into a second generation and boost Southern Africa's position in this sector, where it has been lagging. As an example, Southern Africa produces only 5% of the bio-ethanol production of world leader Brazil.

A key aspect of the Mascoma technology is a yeast that can break down lignocellulosic plant material. With lab research having been undertaken, SBMT is now looking at raising investment to undertake a proof of concept plant for technology adapted to Southern African biomass, which would cost about R75 million. Such a pilot plant would process some two tonnes a day of biomass

for the production of ethanol. The target is to have funding for a facility like that in place early in 2011, with the aim being to have the first commercial plant deal to be done by 2014.

Second generation biofuel energy ticks all the boxes as a sustainable renewable energy option. It can use residual biomass from commercial production processes such as that of paper and pulp, and it can bring underused agricultural capacity into production. Importantly it potentially adds to the green energy mix as an alternative that does not necessarily need subsidies. The rising electricity price increases the potential for biofuel energy to be economically attractive, and it offers policy developers a tangible option to promote the development of green technologies.

It takes into account an IEA prediction that bio-ethanol will make up between 25% and 50% of the contribution towards green transport by 2050. Traditional crops for bio-ethanol are food crops, such as corn in the USA, sugar cane in Brazil and molasses in Southern Africa. However, in spite of the advantage of this being well established first generation technology, the prices of feedstock are increasing and there is the perception/concern about food that could feed the poor being used as fuel.

The second generation technology embodied by the Mascoma technology means the production of bio-ethanol from fibrous plant biomass, with material being sourced from non-food crops such as straw, bagasse, and other residual biomass. Equally importantly, there is no competition with food crops and other land use, and this technology, as it matures, could offer a potentially low cost per energy unit.

The market for the use of biofuels has already been proven through the use of established first generation biofuel technologies; with minimal adaptation, biofuels can be used as a component of petrol supplied to existing motor cars. A key is that refiners say that anything under a 6% contribution of biofuels to the mix does not make it worth their while to set up the plant to implement this, and that will need to be taken into account when future policy is developed.

In many ways technology that breaks down fibrous and woody material into fuel, and which should become more economically viable over the long term as it matures, is the Holy Grail for biofuels. Africa has the greatest potential to benefit, as it would support rural agriculture and socio-economic development with the greatest job creation potential where this is most needed.

Residual biomass can be used. Casper Nice, a former Mondi technical manager who has been brought in to head up SBMT's commercialisation process, says there are many possible feedstock sources, including residual biomass from the Working for Water alien plant clearing programme. This sees people being brought in to clean up water-thirsty invader plants, such as wattle, in South Africa. This produces some 2.2 million tonnes of biomass a year, which is simply discarded, and disposal is an issue. If this and other alien species that are found all around South Africa could be used, the cost of the feedstock for the biofuel process could be very low. In some cases the feedstock has a negative cost, such as the residue from the paper production process, the disposal of which is costly to the paper manufacturers.

SBMT's aim is to commercialise the second generation biofuel technology by initially taking advantage of such low hanging fruit. Its first focus is on the pulp and paper sector, where pulp residue could be used. A major advantage is that the process will avoid the enzyme costs as the material is already processed. The effects of the chemicals in the residue pulp and the reactivity of this residue material to the Mascoma yeast have to be investigated. If this proves successful it will place SBMT in a world leading position.

Second in line for the application of the SBMT commercialisation process would be integration of this second generation biofuels technology with first generation options. A stand alone second generation plant is not yet seen as a commercially attractive option, with rough figures indicating a break-even price comparable to some US$80/barrel. However, the anticipated long term price movement of oil, taking into account increasing scarcity of cheap resources, will favour this biofuel technology into the future.

The consensus benchmark numbers see a capital investment required of R8 to R10 per litre of annual ethanol capacity, with the ethanol production cost being R4 to R5 per litre. Of this the enzymes contribute about R1/litre of production cost so any process that eliminates or reduces this already has a big commercial advantage. This is for a conservative yield of 250 litres of ethanol per dry tonne of feedstock. The size of a commercial range plant is one that can produce a minimum of 40 million litres of ethanol a year and use from some 150,000 to one million tonnes of feedstock a year. SBMT suggests that Monte Carlo economics be used in calculating returns of investment. It entails calculating a probabilistic distribution curve to predict profitability over the lifetime of a project taking into account the range of variables involved. The pulp paper scenario is potentially very attractive, as is that of a combined first and second generation technology plant.

Overall, this second generation technology offers a better energy balance than some first generation biofuel technologies. Importantly, biofuels and cogeneration electricity production can be combined as the material left behind can still be used for this electricity production.

Unlike the existing first generation biofuel production, which features a fermentation process that reacts with the easy-to-process sugars in sugar cane, sugar beet and similar biomass, second generation technology, which looks to break down the more woody fibrous material of plants, requires more advanced processing due to recalcitrance to biological degradation. The reason trees are so resilient and have long lives is because this material is resistant to microbiological breakdown.

Van Zyl says that feedstock and conversion technology are the two most critical components in commercialising the Mascoma process in Africa. A demonstration plant already exists in the USA where wood chip material is used as the feedstock, but SBMT's aim is to evolve and commercialise the technology for biomass

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feedstocks available in Southern Africa.

It is commercially attractive to integrate first and second generation plants because of the overlap of some of the process. A first generation plant that produces ethanol from sugar entails a process of crushing the sugar cane and extracting the fibrous biomass. This sugar is then fermented with the addition of yeast and the alcohol is recovered after a distillation and dehydration process. Fuel blending can then take place.

The production of ethanol from lignocelluloses such as woody material and grasses entails a chipping and grinding process, then mixing with water followed by a steam explosion process at about 200°C and a cooling and detoxifying process. This is followed by a saccharification process with the addition of cellulases. Then follows a process similar to that of the production of ethanol from sugar.

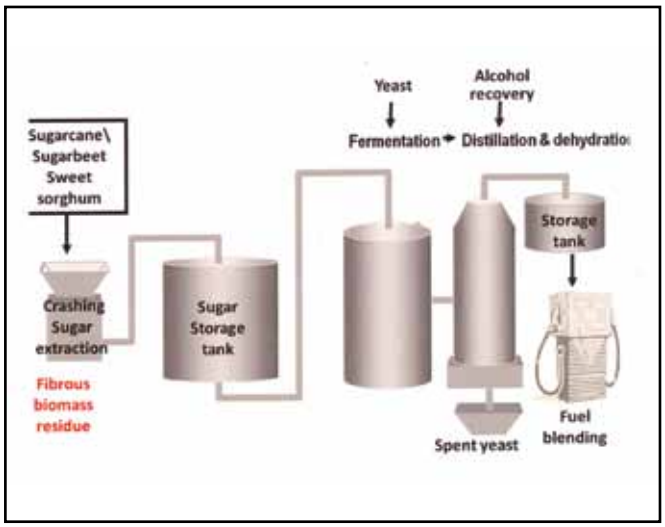
An advantage of the Mascoma technology is that it avoids the steps of saccharification that other lignocellulose production processes require. The key is the use of the Mascoma cellulosic yeast which has been developed to break down such material. Mascoma has already spent some US$200 million piloting the technology which has seen a 2,500 fold improvement in enzyme activity through the use of engineering steps done with the yeast. It achieves significantly increased ethanol production, with the inclusion of pre-treated hardwood, into a mix containing smaller concentrations of commercial cellulases. Alternatively the improved cellulosic ethanol technology achieves comparable results while reducing the amount of enzymes that need to be added by some 60%.

The advantage of the new technology, which brings biofuels from lignocellulose much closer to commercial viability, is that it saves costs by reducing the number of processing units, reduces enzyme costs, and enables the co-production of electricity.

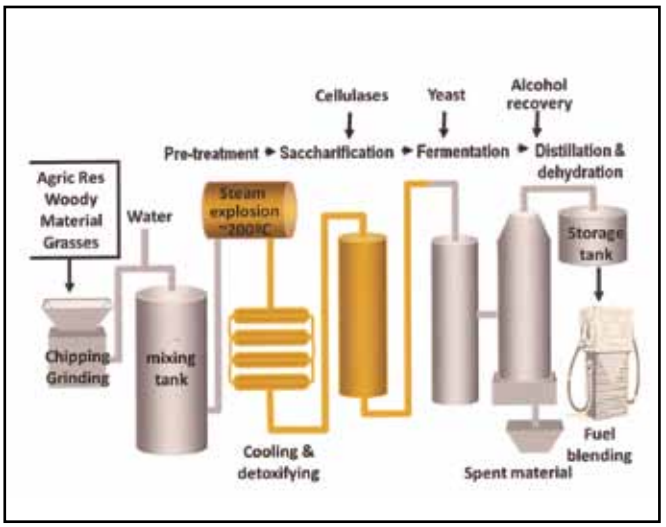
Mascoma has already secured finance towards building the first commercial plant in Kinross Michigan, and Nice says that while South Africa lags too far behind to develop a complete technology package from scratch, the use of this technology will enable this region to progress apace. The argument for South Africa using this particular technology is that it is the global forerunner in cellulosic ethanol technology, and it is the only cellulosic ethanol technology that is partly South African, which enables a local company to have an inside track.

The yeast and process development are plant and feedstock specific, which creates a strong argument for establishing local production of the yeast. SBMT is now looking for funding and partners to enable it to develop the technology further in South Africa. The phases of the development of the technology will include lab-scale yeast development (enzyme production, hardening) and lab-scale optimisation of Mascoma technology integration with local feedstocks (paper sludge, sugarcane, sorghum, and triticale). This can take place quite rapidly, within a year. Then will come process development and risk mitigation in process development plant, and process performance and economics at a scale sufficient for an investment decision to be made. This can take place rapidly as well, perhaps within the next 18 months. Both phases require relatively small amounts of investment capital. The capital required for the first commercial plant for the technology will be some R600 million to R1 billion and could see the first plant of its nature in South Africa in about five years.

This venture does offer the opportunity for a single centralised vision for biofuels development in South Africa, and it is important that this should be linked to electricity co-generation options. Key to achieving this is getting on board stakeholders that can provide development funding, create enabling policy, and partnerships that would bring their own feedstock. Establishing a local producer of the Mascoma yeast is desirable, and while the process could conceivably produce other biofuel products, the stage of technology development means that ethanol is the starting point. More complex end materials could come later.



Schematic of the first generation ethanol process.



Schematic of the cellulose ethanol process.

NMMU 'tees-up' golf machine for competition

With its theme of motion in sport for the 2010 PneuDrive Challenge, students at the Nelson Mandela Metropolitan University designed a machine capable of automatically teeing-up a golf ball for golfers practising shots on a driving range. The team comprised Mark Geel, Sebastian Pillay, Jonathan Petrie and Dylan Townsend.

In the summary document compiled for this competition, the students state that a golfer will typically hit between 50 golf balls (one bucket) and 200 golf balls, and for many of these practice shots the golf ball needs to be teed-up before the shot is made.

On the other hand, when a golfer is actually playing the game he or she will tee-up the ball a maximum of 18 times (unless a shot needs to be replayed from the tee). In an effort to eliminate the wasted energy and effort of teeing-up a golf ball on the practice range, the team developed a machine capable of automatically placing the ball in the correct position, ready to be struck by the practising player.

Investigations by the team found that no automatic teeing machine exists. It also found that some driving ranges provide a short piece of rubber hose that is fixed into the practice mat that allows golfers to place a ball on the hose and practise a particular shot.

There had been some attempts to make a machine that could place a ball on a tee but these were not being used because it was not possible for the player to adjust the height of the tee.

The team came up with an innovative (although complex) solution to build an automatic golf teeing machine that is aesthetically pleasing, easily installed and maintained and will perform consistently and rapidly. The device was designed to be quiet – so as not to distract the golfer – and yet place the ball at the predetermined height, ready to be struck immediately after the previous ball has been hit.

The students point out that the advantages are that golfers can focus on their shot and not be distracted by placing the ball each time it has to be struck; reduce the number of tees that are broken, lost or stolen and minimise the risk of golfers being injured by an errant golf ball while retrieving a tee on the driving range. The machine's cost is a disadvantage, but once installed it needs minimal maintenance.

In outlining the concept, the students say that the golfer will purchase their practice balls that are supplied on a circular disk, stacked in cylinders. The balls, inside the shafts attached to the disk will be carried to the tee and placed on a shaft. Then, once on the shaft, the player presses a start button on a screen adjacent to the tee and a golf ball will be released onto a rubber tee, ready to be struck.

The height of the tee is controlled by pressing the up or down arrow located on a screen at the tee. Once the ball has been struck, another golf ball is automatically placed on the rubber tee at the same height as it was for the previous shot. The process will continue until all the balls have been struck. To achieve this, a servomotor rotates in steps allowing each of the five golf balls in the first shaft to fall through a hole. Then a single ball rolls through a pipe, using a spring and tunnel mechanism where a gripper, attached to a pneumatic cylinder grips the ball and the cylinder moves forward until an inductive sensor detects the head of the cylinder.

Upon detection of the head of the first cylinder, the gripper will release the ball and the first cylinder will return to its initial position. The ball will fall onto the rubber tee that is attached to a second cylinder and a vacuum pump will hold the ball on the tee using suction. The second cylinder will be raised to a set position (determined by the player) using a controller attached to the cylinder.

Once it reaches the pre-set height, the vacuum pump will switch off and the golf ball will be ready to strike. A light sensor placed inside the tee will detect when the golf ball leaves the tee and, once it has, the cylinder will retract and return to a set position where the entire process is repeated until all the balls have been struck (or until the player chooses not to tee up the golf ball).

The students considered using a funnel system rather than a disk but the problem was that balls consistently got stuck in the mouth of the funnel and so this idea was dumped. The team also discarded the concept of using a gripper on a piston to adjust the tee.

It was decided to rotate the ball carrier at regular radian intervals using a Festo electric motor coupled to a position encoder to monitor the rotation. A planetary gear unit fitted directly to the output shaft of the motor removes axial forces from the shaft of the motor and reduces the output speed that is controlled via the controller unit.

These features are necessary to control the motor and allow it to rotate to the various positions as can be seen in Figure One.

A toothed shaft is attached to the gearbox output shaft and the encoder shaft and a pulley is used to drive the square gear tooth that fits into the base of the ball carrier when it is placed on top of the base holder. When the motor rotates, the pulley moves, driving the square tooth and rotating the ball carrier to allow a column of balls to fall into the feed pipe.

A motor is required to operate the single-ball delivery system and must be able to make a 90-degree rotation, then rotate back to the original position, moving the drum-like mechanism containing the ball towards the release position, where a spring will force the ball outwards, down the shoot and into the jaws of the gripper. The motor is mounted on a plate on the extrusion frame and the drive unit connects directly to the rotating drum of the single ball delivery system using the square drive unit connected to the output shaft of the motor.

The students performed stress calculations using finite element analysis in Catia and calculated that the total force that needs to be resisted is 36,3 Newtons and these tests confirmed that failure due to cyclical loading would not occur since the cycle times are too large and the stresses applied are too small.

Further calculations were done to determine the stress on the lip of the machine and the students showed that a combined loading of 3,282 kg would be exerted and this was nowhere near the yield strength, so lip failure was unlikely too.

A Festo horizontal cylinder with a specific stroke was selected and, in terms of the design, a gripper would be attached to the piston rod allowing the ball to be moved horizontally and dropped from a pipe onto the tee in its vertical position.

The chosen gripper was able to open to a width of 42,4 mm, sufficient to grip a golf ball that is just 40 mm in diameter and a mass of 47 g was used for the golf ball as this is the maximum mass allowed by the rules of the United States Golf Association and the Royal and Ancient Golf Club at St Andrews – the two predominant rule-making bodies in the golfing world.

Then the students selected a Festo pressure sensor to detect when the golf ball, having travelled the length of the pipe, lands on the tee and an inductive sensor was chosen to actuate the release of the ball by the gripper and retract the horizontal cylinder.

The sensor detects the head of the piston (not the gripper) as it is made of steel rather than aluminium used to make the gripper and the sensor is more sensitive to steel materials.

A vertical cylinder is then used to lift the tee vertically and it has a piston rod attachment that will facilitate the mounting of the tee and allow a vacuum to hold the ball in position. The position encoder determines the correct position of the cylinder as it moves. When the vertical cylinder is in its 'home' position, the vacuum is turned on to create suction so that the ball doesn't move as the cylinder is raised. At the end of the cylinder's stroke the vacuum is switched off.

Three 5/2 solenoid actuated valves with spring returns were used to actuate the two cylinders and the single gripper. An optical sensor is used to detect the presence of the ball and when it detects that the ball leaves the tee, it switches off.

Finite element analysis (FEA) was conducted on the tee and the modulus of elasticity chosen for the rubber tee was 5 MPa, giving the tee enough flexibility without restricting the movement of the golf club when the tee is struck. This modulus of elasticity provides the necessary stiffness for the tee not to buckle.

The results from the FEA indicated that there is almost no stress at the base of the tee where it is mounted onto the piston rod attachment and will fit securely onto the piston rod using an interference fit allowing it to be secured in place with circlips.

The stress analysis on the tee was different from the FEA as the modulus of elasticity is not taken into account and the higher bending stress was shown to be at the base of the tee. The tests were based on maximum club-head velocity hitting the heaviest type of golf ball, using the heaviest club permitted under the rules of golf and showed:

- The highest bending stress on the tee was 21,9 Nm;
- The maximum shear force was 270 Nm;
- The maximum bending stress on the tee was 359,13 MPa;
- The maximum shear stress on the tee was 16,95 MPa.

The tee needed to have a yield strength of about 400 MPa.

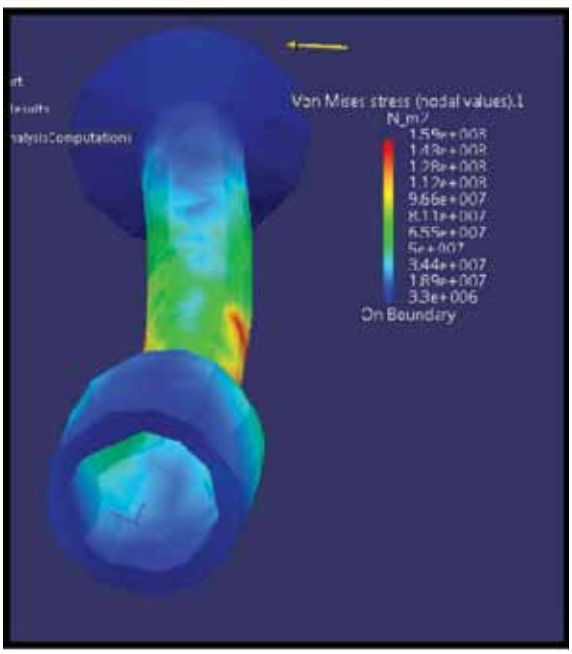
In summary, the holding mechanism is used to hold the golf balls and once placed on the machine, allows the release of the balls in a controlled manner. It has ten equally-space cylinders, each holding five golf balls. At the base there is a hole that rotates on a plate, allowing a single tube of golf balls (five at a time) to be released into the receiving cylinder. Another mechanism is activated in the receiving tube to allow one ball to be released at a time.

The single-ball delivery system uses a rotating disk, a sleeve and funnel to carry the balls to the vertical tee mechanism. A stepper motor is used to rotate the disk backwards and forwards. The sleeve is fixed in position and a spring is compressed as the disk rotates holding a single ball and, because the disk only has a single point of entry, the other four balls remain in place.

The guiding spine prevents the ball being rotated from falling out of the rotating disk and guides the movement of the plunger, providing stability for the spring. Once the disk has rotated to the correct position, the spring releases its stored potential energy, forcing the ball along the tunnel to the next part of the system and the disk rotates back to its original position.

The entire process starts when the start button is pushed and the pressure sensor detects a ball, actuating the vertical piston in its home position, causing the gripper to close and allowing the cylinder to move outward. The piston rod reaches the inductive sensor, the gripper releases the ball and the horizontal cylinder retracts.

The ball will be covering a hole with the optical sensor and the vertical cylinder will rise to the correct position as a vacuum holds the ball in pace. When the ball is hit from the tee, the optical sensor will register a pulse of zero and the vertical cylinder will return to its home position to 'load' the next ball.



Tshabalala scores a winner

Stellenbosch University students, surrounded as they are by mountains and within a few minutes drive from the sea, clearly have the time, space and inclination to invent highly complex engineering solutions for sporting problems.

Following the theme of motion in sport for the PneuDrive Challenge, the four Stellenbosch students, IN Deetlefs, T Mofoken, RS du Plessis and AC Oelofse invented the Tshabalala: The Soccer Ball Shooting Machine that can be used for goalkeeper training and for set-piece training of the entire football team.

The design presented by these students – and incidentally, the winning design for the 2010 PneuDrive Challenge – was for a machine that will meet the shortcomings of current training regimens used by coaches for their soccer team. The Tshabalala is able to simulate a wide number of kicks as well as a quick pass-and-shoot scenario.

This is achieved by allowing the Tshabalala to move rapidly along a track on a trolley and uses a turret to fire a shot at a specific point in the goalmouth. It can be used as a stationary system for practising set-pieces from, for instance, a corner-kick.

The Tshabalala is capable of imparting spin onto the soccer ball to make the simulation, and therefore the training, that is much more realistic. The machine is controlled via a wireless console by the coach on the field.

Soccer, or association football to use the more formal term is the most widely-played sport in the world and there are 208 countries registered as members of the international governing body Federation Internationale de Football Association, three more than the International Olympic Committee.

The immense popularity of the sport leads to fierce competition between clubs and countries and vast sums of money are spent on the players, the coaches and managers and the sponsorship and merchandising opportunities.

Professional soccer clubs are constantly trying to improve their results and spend billions of Rands every year on buying the best players, the best coaches and the best equipment.

A soccer team comprises a single goalkeeper and ten other players who have defined roles in terms of the defence, (defenders) the midfield (midfielders) and the attack (or strikers). Training regimens differ for each group. Goalkeepers, as the last line of defence, have to prevent opposing players from scoring a goal and to achieve this they must have quick reflexes and extremely good eye and hand co-ordination.

The conventional method of training a goalkeeper is to have a number of players kick soccer balls towards the goal in quick succession or to have a single player repeatedly kicking the ball towards the goal.

Neither method is particularly effective: firstly with different players taking a succession of kicks, only a percentage of the shots are on target or test the goalkeeper; secondly, with one player taking the practice kicks there is always the risk of strain or overuse injuries occurring in the muscles.

Set-pieces are practised from a corner or an indirect free-kick while a direct free kick allows certain players to hone their ball skills, ball control and aim by taking a shot at goal.

To practise set-pieces, the ball is placed on a particular spot (where a foul may have occurred in the case of a free-kick) or in the corner arc (for a corner kick) and a nominated player takes the kick and the midfielders and strikers attempt to score a goal.

The students identified the fact that, when practising set-pieces, it was almost impossible for any player kicking the ball to exactly replicate the kick that had just been taken. Moreover, when a goalkeeper wants to practise, the current method of using several players to take a succession of shots also meant that the shots were not controlled or replicated. This makes any training difficult.

Much of the activity during an actual soccer match is dynamic with players from opposing teams passing the ball to each other rapidly (not always accurately) before there is an attempt at scoring. While there are machines that can be used to kick the ball from a set-piece, there is no machine that simulates the pass-and-shoot character of a real soccer match.

The students also found that there is no standardised method of evaluating a goalkeeper because the tests are not uniform or repeatable. So teams tend to evaluate performance on other criteria, such as the number of matches played, the number of goals conceded and so forth.

An automatic machine such as the Tshabalala would resolve this conundrum by providing a standardised test for any goalkeeper. Moreover, the machine could be used to improve any weaknesses that the goalkeeper might have.

Before designing their new machine, the Stellenbosch students did some research on the automatic kicking machines that are currently available on the market and found the JUGS that uses two wheels that spin at synchronous speeds to propel a soccer ball and impart spin in the horizontal plane on the ball.

The other machine – oddly enough designed by engineering students in Zurich – is known as Team BendIt and this machine uses belts to propel the ball and it can impart spin in the horizontal and vertical planes. Both machines are effective for set-piece training but cannot provide pass-and-shoot simulations.

So without batting an eyelid, the Stellenbosch students set out to design a machine that could be used for pass-and-shoot simulations and for set-piece training with a high degree of repeatability.

Their solution was to accelerate a machine along a track at speeds similar to those used when passing a soccer ball from one player to the next and then take a shot at goal from some point along the track.

The design of Tshabalala would allow it to be used from a stationary position for set-pieces and moving along the track for a pass-and-shoot simulation. Because the team's coach is invariably mingling with the players during training, it was essential for the Tshabalala to be wirelessly controlled from a simple, easy-to-use handheld console.

The machine uses contactless energy transfer for the moving trolley that has a rotating turret from which the soccer balls are fired. So the components of the Tshabalala comprise:

- Turret – A moving assembly connected to the trolley that runs along a track. The turret accurately shoots the soccer ball at the goalmouth.
- Trolley – A solid frame that runs on the track with the turret on top of it.
- Track – A rail structure with lip channels along which the trolley and turret move.
- Track motor – A motor situated at one end of the track that moves the trolley using two tooth-belts connected to the trolley.

The track would typically be connected on the line of the large box in front of the goalmouth. However, the track can be angled in different directions if necessary.

The Tshabalala is able to project a soccer ball through the air at different ball velocities, directions and with different degrees of spin. It is controlled through a wireless interface and offers the option of manual, semi-automatic or fully automatic operation. It can be used on the track or in a stationary, fixed position.

When mounted on the track the Tshabalala would simulate pass-and-shoot functions and when used in a stationary position would be used to simulate set-pieces for a free-kick or a corner. It needs to be more accurate than those machines currently available and also needs to have a holder for a number of balls to minimise reloading. It must be able to control itself so that when operated in automatic mode the ball fired will not only reach the goal but will be sure of entering it as well.

The students also wanted to make certain that the machine was safe to use, easy to calibrate and assemble and require a minimum amount of maintenance.

With these things in mind – and many other considerations too – the students set out to design the Tshabalala and soon realised that when moving along the track it would need to have three axes of movement that would determine the direction in which the ball left the turret.

One axis is translational and the other two rotational. The trolley and ball velocity are dependent on the rotational velocities of the track motor and the motors on the turret respectively.

In order to make the Tshabalala attractive as training equipment for a soccer team, it needed to have both a manual and an automatic mode so that it could meet the needs of multiple uses. The main difference between manual and automatic operation is whether the input is given manually or calculated automatically.

Ball velocity is restricted to between 20 m/s and 30 m/s and the spin parameter is between 0 and 0,3 for the semi-automatic and automatic operational ranges. The values are scaled accordingly via the console. So, 100 percent shot power will always relate to a ball velocity of 30 m/s and 100 percent clockwise spin will always relate to a spin of 0,3.

In manual mode, a user manually selects inputs for the Tshabalala, including azimuth and elevation angles of the turret. This provides full control of the flight path of the ball and would commonly be used for set-piece training. The user can select any type of ball trajectory by selecting shot power, spin, azimuth angle, elevation angle and track position (if applicable). The ball is fired using the 'Go' button.

To alter the settings, the elevation angle is controlled by depressing the 'Up' button on the wireless console and is decreased by depressing the 'Down' button. The turret is rotated clockwise using the 'Right' arrow and counter-clockwise using the 'Left' arrow.

Ball velocity and spin are unrestricted in this mode to allow for long shots. However, the students point out that theoretical values have been calculated based on the fact that the maximum speed of the motors is attained at 80 Hz but the motors lose torque when operated at above 50 Hz.

Ball velocity and spin are not able to be set to maximum at the same time because spin is proportional to the difference in belt speed, meaning that either ball velocity is at its maximum or spin is at its maximum. It is not advised to operate the Tshabalala at the maximum values, however, as ball damage is likely to occur.

In semi-automatic mode the turret runs on the track and each ball is fired to hit a specified point in the goalmouth. Each input is given manually but, using the goal position input on the console, the azimuth and elevation angles are determined by the machine automatically. This mode of operation is designed to train goalkeepers to stop shots

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but allows the coach to control what shots are being executed.

To do so the coach selects the position of the trolley on the track, then selects the amount of spin and the power of the shot or ball velocity using incremental sliders. There are nine predetermined shot positions spread across the goalmouth and the user selects one of the positions using the 'Shot Position' buttons.

The cycle starts when the coach presses the 'Go' button and the track motor moves the trolley to the new position. The DSMI adjusts the azimuth angle to the new value and so forth. The ball is then fired. If the 'Go' button is pressed again the exact same shot will be fired.

In fully automatic mode, the Programmable Logic Controller (PLC) calculates each input automatically and randomly and the Tshabalala executes different shots on a random basis until its operation is stopped or until it runs out of balls. The turret has to be mounted on the track to run in fully automatic mode. So the Tshabalala will select a random track position, a shot trajectory and a goal position. It will execute this shot and then randomly start on the sequence for the next one. This mode of operation is intended to train goalkeepers.

The accuracy of the Tshabalala is determined by the accuracy of the three axes of movement, the speed accuracy of the motors on the turret that propel the ball, the belts that are connected to the trolley and the friction between the wheels and lip channels on the track.

Abrasion-resistant polyurethane timing belts with high-tensile steel tension cords are used for movement of the trolley on the track and some of the advantages of using this system include:

- The timing belts maintain a constant length and won't stretch because of the steel tension members. The belt speed of up to 80 m/s can be achieved.
- Even distribution of the load during use that also allows the transmission of high amounts of torque. The belts dampen sudden shocks or changes in loading and are maintenance free.

These factors give the Tshabalala high accuracy, high repeatability and quick acceleration. When the machine is mounted on the track its purpose is to project a soccer ball so that it reaches a specified position in the goal.

Most users are likely to use the machine symmetrically, so that the goalkeeper can receive a shot from the left or right side. The students point out, though, that the track can be mounted diagonally across the goals as well.

For the design, the students chose to mount the Tshabalala on the horizontal line of the big box in front of the goal as this would represent the greatest distance from the goalmouth, the greatest track length and the greatest required ball velocities. However, small installations are possible using shorter tracks or setting the track closer to the goal.

Calibration of the machine is needed for the track position and the Matlab program does the rest of the calculations. Determining the precise flight path of a soccer ball is difficult and tolerance blocks are used to compensate for most factors that might influence the theoretical flight of the ball.

However, if a shot is consistently off-target, the table generated by the Matlab program can be adjusted by replacing the initial azimuth and elevation angles of the turret for a specific shot. This is done by switching the machine to manual mode and adjusting both angles until the required shot is executed. Then those new angles are saved by the user in place of those generated by the Matlab program.

It is important to easily calibrate the machine, and to achieve this a limit switch is installed on the track, close to the track motor as a reference point for the Movidrive. As soon as the Tshabalala is switched on, reference travel is done and calibration completed.

For design simplicity, the students provided designs for each of the different sub-systems used by the Tshabalala. These sub-systems comprise: ball acceleration and spin, the ball loader sub-system, the turret elevation sub-system, the turret azimuth sub-system, the trolley sub-system and the track sub-system.

The design uses a combination of electrical and pneumatic components and wireless electricity is provided to the turret, which limits the amount of peak power that can be consumed because of restrictions on the number of pick-ups that can be fitted to the turret trolley.

The limited peak power consumption, in combination with high inertia loads, led to the use of an onboard compressor and accumulator and this means that the energy needed for high inertia loads can be stored in the accumulator.

A finite element analysis (FEM) had to be done on various components, particularly the turret frame as if it deflects, accuracy is affected. The FEM analysis showed a deflection of 0,4755 mm at the end of the turret frame, which is minimal and would not affect the accuracy of the Tshabalala.

For movement on the track the Tshabalala comprises a motor with alternating current, a synchronous servo motor with dual shaft gearbox and resolver, a drive inverter for speed control on AC motors (Movidrive), a drive inverter for position control on the synchronous servo motor, a Movitrans mobile converter and installation plate, the electrical pick-ups and a power supply cable.

The Movitrans provides a method of wireless energy transfer by means of induction and can be used in high-speed applications as electrical energy is transferred without contact from a fixed conductor to a mobile consumer.

The students designed a pneumatically actuated ball-loader sub-system comprising the ball magazine (to hold the balls), a loading bay plate and stop arm, a roll preventer and guide plate, with a Vesconite bush and a Festo cylinder.

The system is actuated by a Festo cylinder which, in combination with other mechanisms, loads balls from the ball magazine onto the ball acceleration and spin sub-system.

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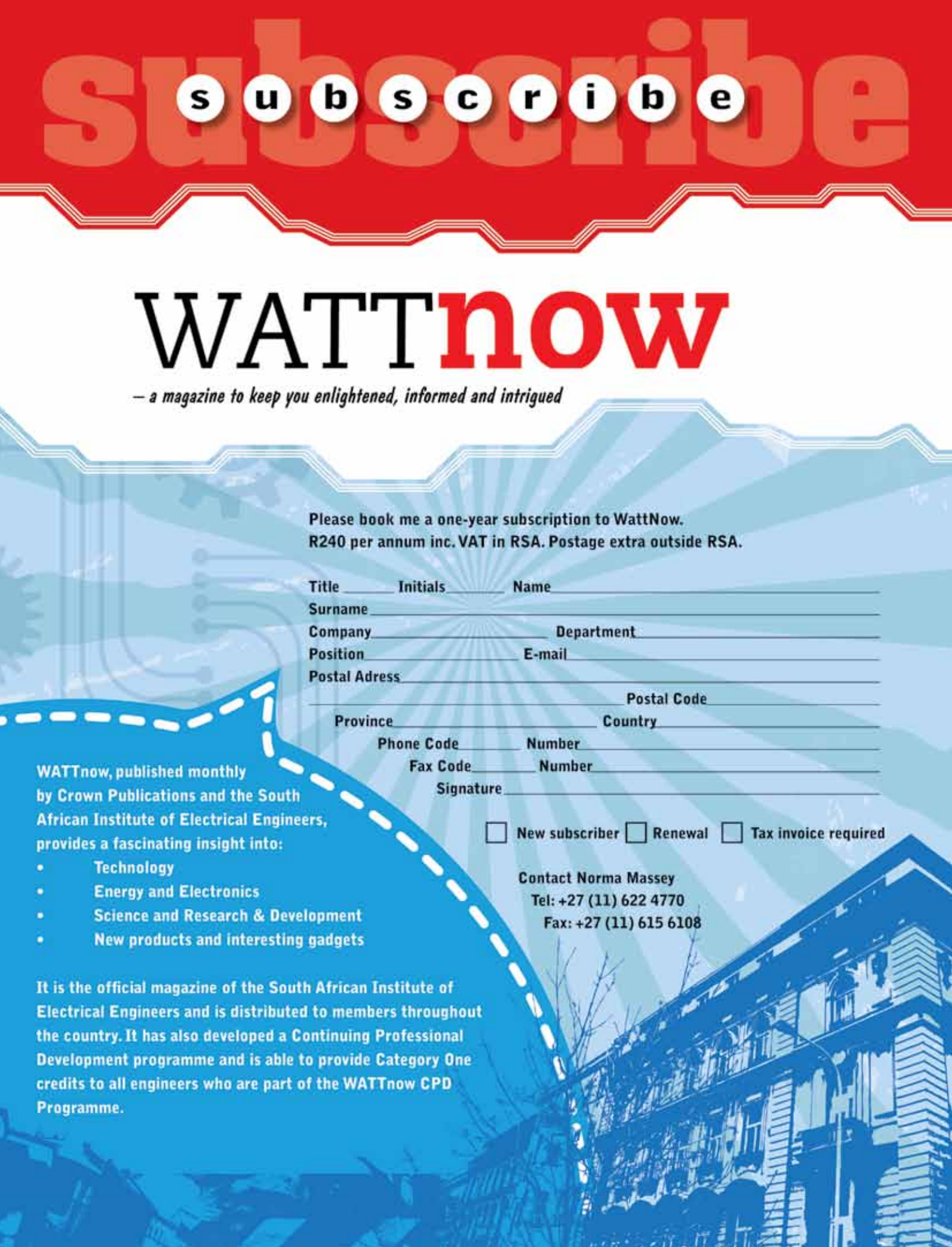


The ball acceleration and spin sub-system is responsible for taking the ball from the ball loader to the desired shot speed while simultaneously imparting spin along the vertical access so that the ball will curve after it has been fired. The students calculated that for a maximum design speed of 30 m/s with maximum spin of 14 revolutions per second the ball should curve four metres over a shot distance of 30 m.

The ball acceleration and spin sub-system comprises the frame, two hinge shafts, ball-size compensation plates, a polyurethane V-belt, main and idler pulleys, two SEW motors and a V-belt setup system.

For the turret elevation sub-system the elevation angle, in relation to the ground, must be set and the elevation angle is critical because a small angle error at the turret leads to a much larger error at the target 30 m away.

The system uses a Festo DSMI with power being transmitted to the hinge shaft of the ball acceleration sub-assembly via a synchronous belt and pulley system that prevents slippage. The base frame houses the components for the actuation of elevation and azimuth angles.

The turret has an azimuth angle range of -60 degrees to +60 degrees where the angle of zero represents the turret facing directly forwards. The azimuth angle is actuated by a Festo DSMI, which is welded to the base frame. It has a DSMI shaft that is welded to a flange and bolted onto a Jost turntable to allow frictionless movement about the vertical axis from which the azimuth angle is measured.

The track sub-system is required to accelerate the Tshabalala to a sufficient speed to simulate a pass-and-shoot scenario on a soccer field. The track has three parts, an intermediate section and a front and rear section making installation that much easier. The total length of the track is 42 m.

The intermediate track section comprises lipped channels, the TIS installation place, base and support tubing, mounting and stiffener plates and a connecting angle. The lipped channels constrain the wheels on the track while the stiffener plate is used to provide torsional stiffness.

The support tubing holds the TIS plates in position and maintains a distance of 15 mm to ensure that maximum power is gained from the Movitrans. However, the installation plate and pick-up plate must not be within 80 mm of any ferromagnetic material. To overcome this, the students designed 3 mm aluminium plates to fit between the ferromagnetic material and the installation plate and between the ferromagnetic material and the pick-up plate.

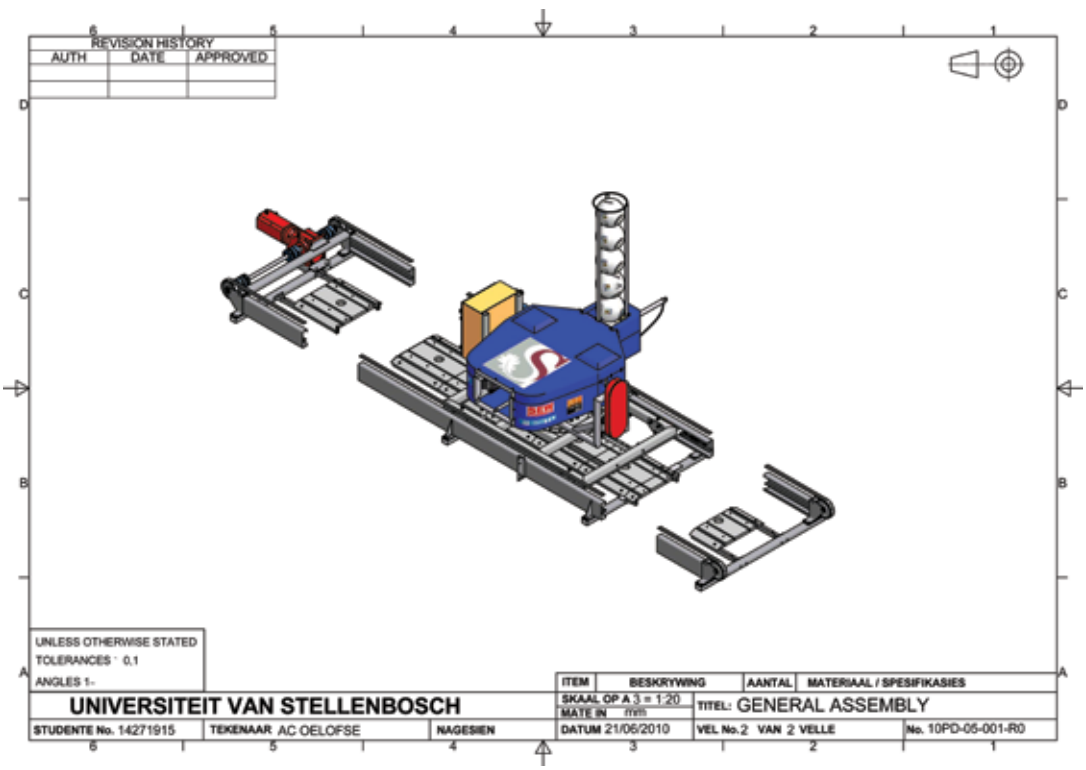
The front track section is similar to the intermediate track section but has the drive assembly fitted to the end comprising the motor and gearbox, two pulleys, a pulley stabiliser and mounting bracket, a drive shaft and couplings, a motor brace and mounting bracket.

The SEW motor used provides the trolley with an acceleration of 6 m/s and a velocity of 6,5 m/s. Two 212,2 mm pulleys are connected to the lipped channel using a mounting bracket bolted to the channel mounting plate.

The rear track assembly is also similar to the intermediate section but has a pulley fitted to it at one end.

The trolley assembly is used to move the turret along the track and comprises a compressor, wheel, turntable, wheel mounting brackets, a turnbuckle to tighten the belts, a distribution box, cable tray and pick-ups. The wheels are made of industrial polyurethane.

Three pick-up plates are connected to the trolley to transfer total power of 4,5 kW. The turntable allows the turret to rotate while the distribution box houses all the electric inverters and part of the pneumatic controllers such as the PLC. A 0,5 kW compressor and 5



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litre accumulator are mounted to the distribution box.

The Tshabalala uses a standard synchronous timing belt to minimise elongation, which is important for positional control of the trolley on the track and is critical for accuracy. To ensure the Tshabalala is easy to transport, a standard ATV (quad-bike) trailer was chosen and modified to include two guide channels for the trolley's wheels.

As part of the project, the Stellenbosch University students then carefully investigated the physics of a soccer ball, particularly when it is in flight. This gave them the necessary understanding for the automatic and semi-automatic operation of the Tshabalala and led to ball velocity being restricted to between 20 m/s and 30 m/s and spin limited to between 0 and 0,3.

The calculations were done from empirical data gathered using the Teamgeist ball that was selected for the 2006 World Cup. Similar data was not available for the Jabulani ball that was used in South Africa this year.

The students realised that there was a total of 28 611 possible combinations of user input if each possible shot on goal was to be calculated manually, which was not practical and would negatively affect the viability of the machine.

To overcome this the students wrote a Matlab program to determine the flight path of a ball for a set of given inputs in Cartesian co-ordinates for the semi-automatic and automatic modes of operation. The set of initial conditions used in the program were taken from the point when the ball and the belts no longer make contact.

The Matlab program determines the sum of the forces on the ball to calculate the acceleration and then determine the speed and position of the ball at the end of the time. This is done repeatedly until the ball in the goalmouth reaches a specified final position.

There are nine goal positions that can be selected by the user. Each goal position relates to a Y and Z co-ordinate. The Matlab program considers every combination of spin, ball velocity, track position and initial azimuth and elevation angles of the turret to determine the final position of the ball.

The Matlab progam essentially fixes the spin, ball velocity, track position and elevation angle and then scans the goal for tolerance blocks. The elevation angle is then changed to the next increment and a scan of the goal is done again. When the final position corresponds to the co-ordinates of the centre of a tolerance block, the set of initial conditions for that shot are saved. This is done for all combinations and then a table is generated which relates to the initial conditions for every possible shot. This table is then included in the programming of the PLC. The table corresponds to one complete scan of all nine shot positions while keeping track position, ball velocity and spin constant. The complete table is an extended version of this, containing all possible shots on goal. For wireless communication with the Tshabalala, a hand-held console is used. It has incremental sliders for ball velocity, and selection buttons for position and spin and push buttons for the 'On' and 'Off' function.

The console also contains a transmitter that communicates with a receiver on the Tshabalala to activate the controls on the servo motors, mounted on the trolley and mechanically rotate rotary potentiometers which are connected to a 24 V DC power supply. By doing this the source voltage can be scaled according to the angle of rotation of the potentiometer and used as an analogue input to the PLC. Each scaled voltage corresponds with the magnitude of an input.

The receiver, transmitter and servo motors are supplied by Futaba and potentiometers from Bourns. A Pulse Code Modulation (PCM) system was used for the design, as it will not transmit to the servos if it encounters interference. Standard servo motors were chosen to minimise costs and power consumption.

The rotary potentiometers were connected directly to the servo motors with a gear ratio of five meaning that a servo motor with a rotation of 60 degrees will cause a potentiometer to rotate 300 degrees. Input from the console is received via a radio receiver onboard the trolley and relate to output on servo motors, which displace potentiometers to generate an output voltage. These output voltages are used as input voltages on the PLC and range from 0 to 10 V and is divided into five two volt increments.

Thus an input voltage of between 0 and 2 V will relate to the first increment, between 2 V and 4 V the second increment and so forth. The potentiometer is set to give an output voltage in the middle or the range (1 V, 3 V and so on) to ensure the correct voltage levels are achieved.

Using these systems, the control of the Tshabalala is effective and simple for the end user (although not nearly as simple for the designers). The students chose a Siemens Simatic S2-700 PLC for the system and all control logic is programmed into the controller, which also contains the Matlab extended table.

As energy saving was a requirement of the project, the students realised that a significant amount of energy is dissipated during the deceleration process when the trolley stops. This kinetic energy can be recovered using a regenerative power supply and used to power other components.

Power losses occur when converting electrical energy to mechanical energy and through friction.

The Tshabalala is an elegant and highly practical machine that might prove invaluable to any soccer team and considering that it costs just over R500 000 to build, it should represent a viable option for the sophisticated training of soccer players in various different situations. It has a high degree of repeatability making it ideal for goalkeeper training or for playing of set-pieces such as a free-kick or a corner. Essentially the Tshabalala can replace any player that kicks a ball on the field and can do so with greater accuracy and repeatability than any player as well.

That makes it an invaluable asset to any coach, anywhere in the world.

University of Jo'burg wants to beat the 'keeper

Although the FIFA World Cup 2010 is little more than a treasured memory for most people, players competing in the event may have benefitted from the design concept dreamed up by students at the University of Johannesburg who planned to create an automated goalkeeper that can return a ball to a player who is practising.

The point about this automated goalkeeper is that it provides players with a way to take kick after kick and never have to walk to the back of the net to collect a ball. Moreover, the automated goalkeeper is capable of making 100 percent of the saves from a predetermined spot a fixed distance away.

The design concept is the brainchild of students ACS Levy, SPJ Rose, M Isvarlal and J Taylor who are studying for a Bachelor of Engineering in Mechanical Engineering at the University of Johannesburg.

According to the submission, the design of an automated goalkeeper capable of returning the ball to the player was chosen because it incorporates several pneumatic systems and linear drive systems and fits in with the PneuDrive Competiton's theme of Motion in Sport.

The students claim that their final design provides good functionality while demonstrating the versatility of the Festo and SEW product range.

The final product is designed to perform as an automated training device that can be used by people in most age groups to improve personal performance in the chosen sport while providing some fun and stimulation for the players involved.

In terms of the design specification, the machine uses a 2,2kW compressor for pneumatics, fits into a standard goal-mouth (three metres wide and 2 metres high) and its travel time between the posts is less than three seconds vertically or horizontally. The system weighs less than 200 kilograms and the operational system pressure doesn't exceed 600 KPa.

The automated goalkeeper is designed for indoor use and can save shots travelling at a maximum speed of 30 metres per second. It can be built for under R300 000.

The students first considered various products that might meet the design criteria and these included a cricket stump replacer, an archery demonstrator, an automated ball retriever and an automated goalkeeper. However, they felt that they could improve on the automated goalkeeper by including a ball return function and that's the final product they elected to design.

The machine would be used to improve the skills of all football players – excluding the goalkeeper – particularly in terms of accuracy when taking a shot at goal and would allow an individual to practise alone as the ball would consistently be returned to the player.

The machine uses two laser distance sensors (for the X and Y axes respectively) and these are positioned at the point where the ball is to be kicked. The laser distance sensors are available from Festo. When the ball is kicked through the laser grid, its X and Y intersection is logged. Then, by means triangles in the X and Y planes respectively, the final position of the ball in the goalmouth is predicted.

This predicted position is sent to the controllers for the main translational system and the vertical translational system. The main translational system uses two electrical linear motors positioned on either side of the horizontal bars of the goalmouth and work in unison. These linear motors are used in conjunction with Festo's DGE linear axis and CMMS controller.

The linear motors work simultaneously and a steel plate connected to the motors provides the platform onto which a vertical sub-system is mounted. The vertical sub-system provides the vertical motion using a large pneumatic cylinder.

It rests on the top portion of the horizontal translational system and has a maximum stroke of two metres so that it can cover the entire goalmouth. The final sub-system is the ball-catch-and-return system.

This system catches the ball in a mild-steel cage that is capable of stopping the ball and keeping it constrained. In conjunction with the rest of the system (that comprises a pneumatic actuator and linear motors) the box returns to a zero position in the horizontal and vertical centre of the goalmouth. Once in that position, it returns the ball to the player using a swivel module (DSMI) from Festo.

The swivel module is connected by a mild steel rod from the rotational axis to a plastic return basket. When activated from the zero position, the DSMI swivel module propels the ball with a predetermined amount of torque that will carry it the required distance so that it can be replayed.

The ball return sub-system has an interface unit that will provide both analogue and digital inputs. However, detailed programming of this controller is required to synchronise the electrical linear drives and the pneumatic drive with the laser prediction system.

To make the machine, the students had to perform a number of calculations using the standard size indoor goal that is three metres wide and two metres high. The average ball speed kicked by an adult player is 110 km/h, equivalent to 30 m/s. This is the instantaneous velocity of the ball as soon as it leaves the kicker's foot (about 0,01

seconds) and from that point it starts to decelerate because of gravity and air resistance.

For the design, the students decided to ignore the effects of gravity and air resistance on the trajectory of the ball from the spot where it was kicked. However, the coefficient of restitution is a measure related to at what speed the ball bounces up, compared with the speed at which it hits the ground on the way down.

This ranges from zero, where the ball doesn't bounce up at all to one where it bounces to the same height every time. The students assumed that the coefficient of restitution was zero as the ball is kicked from a stationary position on the ground (as is the case with a free-kick).

When a boot makes contact with the ball, the energy going into the collision is the kinetic energy of the kicker's foot plus the stored energy in the deformed ball and this results in the energy being a combination of kinetic energy of the ball plus heat. The more the ball deforms, say the students, the more energy is lost to heat.

The students decided to ignore the conservation of energy effect and assumed, instead, that no deformation takes place. Using Newton's second law of motion in its simple form (resultant force = mass x acceleration) or its expanded form (impulse or change in momentum = resultant force x time) a mass, contact time and initial and final velocities are known. The students calculated that the resultant force in the accelerating ball is 1 350 Newtons.

As the air resistance was being ignored the students assumed that no further forces act on the ball during its travel. They also assumed that the contact time of the impact of the ball with the basket of the automated goalkeeper is 0,01 s and hence the resultant force acting on the vertical bar will be 1 350 N.

The resultant force caused by the ball can be used to develop the shearing force on the vertical actuator given the length of the actuators, which is equal to that of the goal dimensions. Moreover, the maximum bending moment can be quantified.

The actuator members are under the combined loading of shear force and bending moment. Normal or axial forces, as well as torsional forces, are not present with respect to the impact force of the ball. However, due to the weight of the basket and the return mechanism, an axial force will be present in the vertical bar.

Given the numerical values of the maximum share force and bending moment, a material profile can be determined and the dimensions calculated. Then, after choosing a durable, lightweight (for rapid acceleration) material with a known modulus of elasticity, deflection, maximum shear stresses, maximum bending stresses, toughness, resilience and other relevant values, a safe structural design with high fatigue life can be quantified.

The vertical bar was modelled as a simply supported beam with one point load acting normal to the axis and an axial force assumed to be parallel and in line with the neutral axis of the vertical bar. This is so the bending moment effects caused by the weight of the return mechanism can be ignored.

The resultant force caused by the ball can be used to develop the shearing force on the vertical actuator, given that the length of the actuators is equivalent to the goal dimensions. Using their own calculations based on diagrams, the students calculated that the maximum bending moment is equal to 675 Nm.

Based on their calculations, the students decided that a hollow square bar with a plate thickness of 2 mm would be sufficient for this.

Using Festo's DGC Quickcalc program the students were able to determine that the force that the piston moves at is -1 683 N based on lever arms on the X-axis of 460 mm and on the Y-axis of 128 mm and with a mass of 20 kg. The linear drive dimensions provide a stroke of 3 000 mm and a diameter of 63 mm.

According to the students, due to idle and reaction time of the linear motors and actuators, there is a limitation on the minimum distance between the free-kick spot and the goal. They assumed that the idle time, or the time it takes for the motors and actuators to respond to the electrical signal generated by the laser grid is very small. They chose to use a value of 0,1 seconds because the exact value cannot be calculated without simulation of the working components.

The time taken for the linear motors to move the width of the goal is 2,91 s and the time taken for the linear actuator to move the full height of the goal is 2,84 s. The neutral position of the cage is in the centre of the goal and therefore the times can be halved to 1,46 s and 1,42 s respectively.

According to the students, from the neutral position it will take 1,46 seconds to save a shot completely to the left or right side of the goal and the greatest reaction time for the automated goalkeeper to save any shot is 1,56 seconds, the time taken to move the furthest distance away from the neutral position plus the idle time.

This means that the ball must be placed a specific distance away so that it is in flight for more than 1,56 when travelling at a speed of 30 m/s. And the ball must be positioned about 400 mm in front of the laser grid. At a distance of 48,6 metres the automated goalkeeper will save 100 percent of the shots provided that the velocity is not greater than 30 m/s.

By shortening the distance between the free-kick spot and the goal, a player will be allowed to focus on more accurate shots that are close to the posts as these will not be saved. It allows players to practise shooting skills based on the principle of beat the 'keeper.

In explaining how this simulation works, the students say that if the laser grid is placed 24 metres from the goalmouth (a challenging free-kick) the reaction time required by the actuator and motors to save such a shot is 0,7 seconds. This means that a portion of the goal area (on the left, right and at the top) close to the posts and crossbar will be open as the motors and actuators will not reach it in time. If the ball enters that space it will not be saved.

The students then did a range of calculations to show which values can be ignored by the computer if the ball is kicked in such a way that it will miss the goalmouth entirely.

To do this, the students assumed that a free-kick would be taken from 16 m and the height of the laser grid 0,125 m. If the ball is kicked and no interference with the grid occurs, it implies that the bottom of the ball, after a metre of travel, is at a height greater than 0,125 m and it will go over the crossbar.

Thus the computer must be programmed to neglect values greater than 0,125 m and not activate the motors or actuators. The same process must be applied to the horizontal projections assuming, of course that there is no spin or curve on the ball.

The height of the grid is set at 0,125 m and the width of the grid is 0,188 m. Anything outside that grid will miss the goal. However, the students concede that the control processes for the Automated Goalkeeper with Ball Return Function are relatively complex and require special programming by a suitably skilled and trained individual.

With regard to the environmental impact of the machine, the students point out that the system relies on pneumatic systems and is intended for indoor use so that it will have no impact on the ecology. It has a recommended exclusion zone and is recommended for us among players who are at least 12.

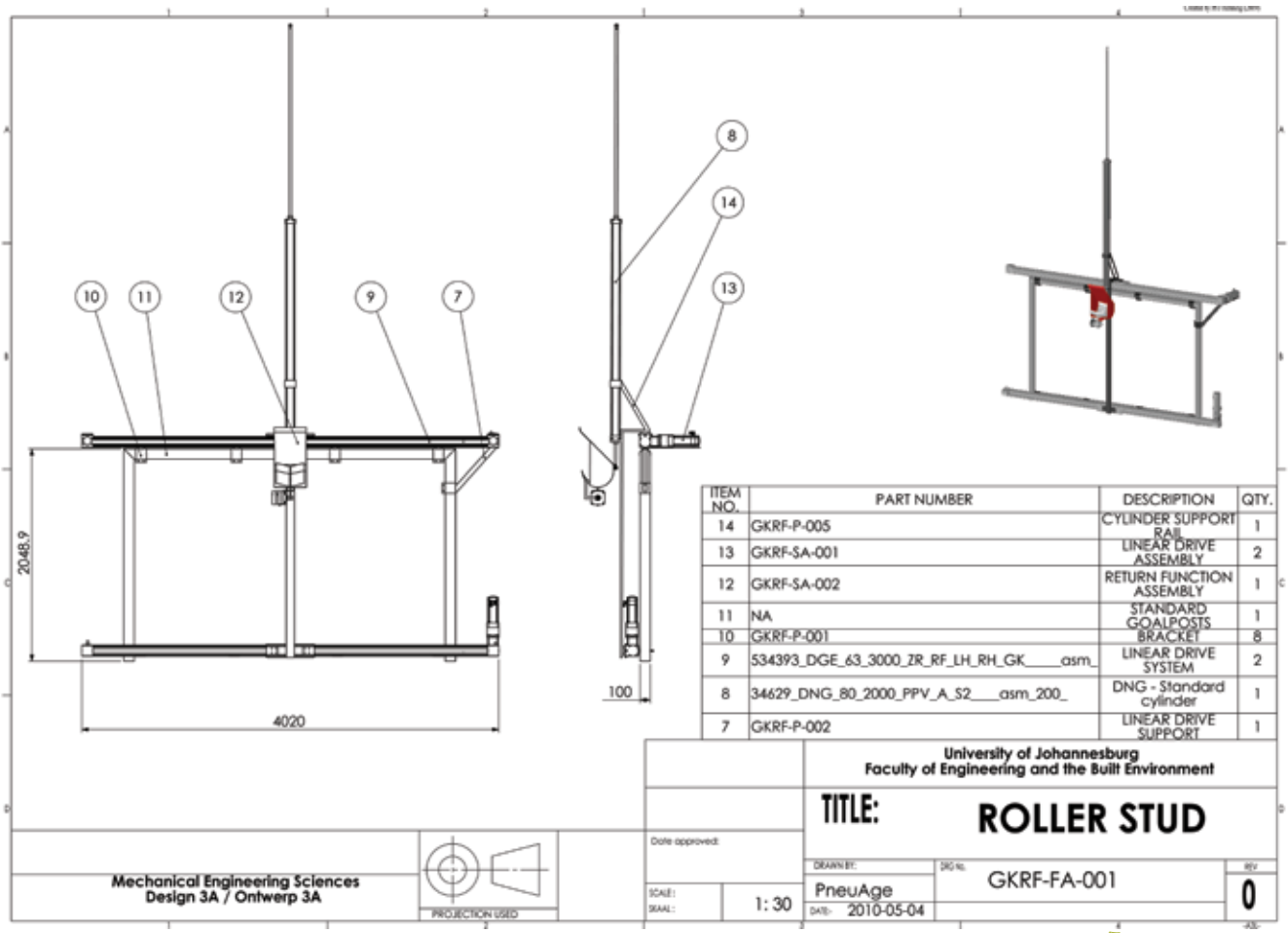
The machine is made from steel while the ball return basket uses polyethylene that is strong, flexible and cheap. It uses a compressor system, a PLC controller and laser distance sensor.

The vertical motion system comprises a cylinder and a valve, two silencers, two flow control valves, tubing and fittings. The horizontal motion system uses two linear drives and two axial units, two gearboxes and motors and two controllers.

The ball retrieval and return system is made from steel but uses a polyethylene basket and comprises a swivel module and a positioning module. It uses the DSM swivel module and is assembled by bolting the cage to a vertical bar and locking the swivel module in position. The basket is locked onto the swivel module using a connecting arm.

The entire machine is assembled on site and in situ and costs just under R290 000.

[Editor's comment: There is no explanation of how the ball will be returned to the player if a goal is scored. So while the system appears to work when the machine saves a goal, the player would still have to retrieve the ball from the net if the goalkeeper was beaten.]



'Keeper Coach – a complex engineering challenge

Take a really simple idea, like building a machine that will allow goalkeepers to practise their techniques in goal and you would think that it would be a fairly simple task of firing a ball in random directions at different intervals. Then take that idea, hand it over to a group of engineers and you start to discover just how remarkably complicated such a project becomes.

That's essentially what Calvin Cunniffe, Cameron Israel, Leemeshen Naidoo and Friedrich WH Schulenberg discovered when they embarked on the quest to design an automated soccer ball-kicking machine to train goalkeepers. The four students are studying engineering at the University of KwaZulu-Natal in Durban.

In fact, in their concluding comments in the report submitted for the PneuDrive Challenge, the students wrote: "The PneuDrive Challenge has been an amazing learning curve, even more so as it serves to form part of the final year design and research project for the University of KwaZulu-Natal. Designs have been altered in ways which would simplify processes using the best engineering methods."

Of course, their comments are what makes this practical competition such an excellent training device for engineering students who face perhaps, for the first time, the reality of devising practical engineering solutions that will be applied in the real world.

The theme for the PneuDrive Challenge was Motion in Sport and the group looked at the various options that had been suggested and chose the automated goalkeeper training device, which they promptly named the 'Keeper Coach.

The device needed to be capable of launching a soccer ball from the penalty box into the goal at various positions. Ideally the device had to randomly select a position to launch the ball to an unpredictable position for the goalkeeper. It was intended as a supplementary training apparatus for goalkeepers.

Moreover it would allow the goalkeeper to practise independently from the rest of the team as the machine would cycle through a pre-programmed shot at goal without being able to predict where the next shot would go. When the ball is returned (by the goalkeeper) to the ball retrieval system, a sensor will be tripped and the next shot played. This allows the goalkeeper to determine the cycle time.

Having designed the machine, the students realised that there were a number of design enhancements that could be added to its operation but these were relegated to future developments rather than incorporated into the final submission to the judges.

The design criteria stipulated that the shot selections had to be made according to the standard goalmouth size of 7,32 metres wide and 2,44 metres high and the maximum speed at which the ball could travel was 120 km/h.

The machine would have to be set up on the penalty spot in the middle of the goalmouth 11 metres from it. Five predefined positions could be randomly selected but the ball had to strike within the goalmouth every time. The goalkeeper had to control the cycle time of the machine.

The students considered various different solutions that might meet the criteria such as a machine with a swivel arm that 'kicked' the ball with its 'foot' and by controlling the direction in which the foot was aiming, a different spot in the goalmouth could be achieved. The students felt that there were too many variables in this design and in any event it was similar to an existing and patented product anyway.

All in all, seven different concepts were carefully considered, analysed and examined before a final design (the eighth concept) was chosen and even then it was still an extremely complicated device to make.

The final design comprised a rotational positioning system, a vertical positioning system, a horizontal positioning system, a powerful ram, a ball lifting system and a ball retrieval system. What seemed quite simple at the outset was quickly becoming more and more complicated.

The first problem was to find a way to kick the ball with a force of 1 400 Newtons or more. Initially a pneumatic drive appeared to solve the problem but the repetitive shock loading on the pneumatic drive would eventually cause it to fail.

The next option was to use an electric cylinder operated by a servo motor turning a ball screw or lead screw to extend a piston. However, while an electric motor can deliver great forces, it can only operate at a maximum piston speed of 0,75 m/s, which is too slow.

So the students considered the option of using a spring to impart force onto the ball. The spring would be compressed and then released and when it made contact with the ball the spring force would be large enough to impart the necessary force to launch the ball at the correct speed.

To compress the spring posed a number of additional considerations such as using an electric cylinder coupled to the front of the spring by an electromagnet. The cylinder would extend until it reached the natural length of the spring. The electromagnet would then activate and the direction of the electric cylinder would be reversed to draw back the spring.

When the ball is about to be fired the electromagnet would simply be deactivated. While this system would work, the students chose what they believed was a more elegant solution to use one of Festo's fluidic muscles.

The fluidic muscle uses compressed air to expand a rubber hose in its peripheral direction. Due to conservation of volume, the increase in diameter causes the muscle's length to decrease, generating tensile force. High-strength fibres support the rubber material, used to form the muscle.

The fluidic muscle offers up to ten times the force of a standard cylinder and has good dynamic response at high loads and so the students chose to use a muscle to compress the spring. In operation, compressed air will fill the muscle, reducing its length and drawing back the spring and when the spring is about to be released, air in the muscle is released rapidly.

Another advantage of the fluidic muscle is that it weighs just 1,245 kg compared with an electric cylinder that weighs about nine kilograms. The reduction in mass allowed smaller components to be used to move the ram (that would 'kick' the ball) and as the moment of inertia would decrease so would the forces it experienced.

The next task was to find a suitable spring with an internal diameter of at least 43,9 mm to contain the fluidic muscle. A coil diameter of 14 mm was selected on the assumption that the wire thickness needed to be fairly large and by using a mean diameter of 100 mm a spring index of 7,14 could be achieved. The design of the spring was conducted through design analysis equations outlined in the Fundamentals of Machine Component Design by Robert C Juvinall.

According to Juvinall this index was in a good range. The number of coils was calculated at 13. The fluidic muscle was designed with the force needed to propel the ball as one of the parameters. A deflection at which the muscle was to operate was used as the second defining parameter. The muscle was to deflect the spring by 60 mm and the spring would have a force of 1 800 N at this deflection.

A nominal length of 350 mm was selected and the required deflection of 60 mm was specified. The operating pressure, using Festo's fluidic muscle design program, MuscleSim, was set to 5,3 bars. The resulting force was 1 787 N and a contraction of 17 percent. A disadvantage of using the fluidic muscle is that the degree of contraction must be less than 25 percent of the nominal length due to limitations on the degree to which the diameter can expand before failure.

This resulted in a large spring length and affected the moment of inertia of the ram. The MuscleSim program recommended that for optimal usage the degree of contraction should be 15 percent or less but the students felt that a contraction of 17 percent would be acceptable as the extra length required to reduce the contraction ratio would increase the size and weight of the ram without any real benefit.

A quick-exhaust value was incorporated into the design to reduce any dampening effects of escaping air when the muscle was rapidly elongated. It operates best when fitted directly to the muscle but this was not possible in terms of the design and so a fitting was connected to the quick-exhaust valve instead.

The mounting configuration allowed one of the muscles to be blocked so that air would enter and release through one connection and this meant that only one solenoid valve would be necessary.

The ram had to be mounted inside a casing to support the spring and prevent vertical deflection as it released or was being compressed. By using two individual cylindrical sleeves and allowing them to move relatively close to each other, the fluidic muscle and spring will function as required.

One of the cylindrical sleeves needs to be larger in diameter than the other to allow the sleeves to slide relative to each other. The sleeves are attached to the spring and as the spring varies its length, the sleeves adjust by sliding one over the other. So the ram design comprises a swivel shaft, an outer and inner sleeve and two end covers.

The ram rotates to the left or right on the swivel shaft with a bearing at each end that is capable of withstanding the recoil force of 1 800 N. To prevent the sleeves from sliding off each other, rubberised stopper units with good impact absorbing properties are used to absorb the spring's kinetic energy and stop the inner and outer sleeves.

Attached to the end of the ram is a device called a 'shoe' made from a rubberised cricket ball. The shoe makes contact with the soccer ball and needs to be hemispherical and must be joined to the ram. This was achieved by gluing a circular aluminium plate to an aluminium rod that is attached to the outer sleeve's end cover.

The hemispherical shape means that the spring's force is not concentrated on one point when the ram is fired as, if it was, this might puncture the ball. Moreover, rubber materials have high friction factors that reduce any slippage between the ball and the shoe on contact.

So now the team had worked out how to fire a soccer ball and the next problem was to position it accurately when it was slammed at the goalmouth. So the physics of a soccer ball had to be considered. The effect that spin has on the ball's motion was used to control and vary the trajectory of the ball in the vertical plane.

However, horizontal positioning of the ball was aimed at not introducing spin and the ball was to be hit along the centre axis in the direction that it should fly to eliminate curvature within the horizontal plane. An electric drive would be used to move the ball vertically and the distance away from the ram would be controlled by varying the length of the electric drive shaft.

The vertical positioning system allows the ball to be accurately located in front of the ram and it is broken down into two sub-systems that are used to provide accuracy. The first sub-system controls the distance between the soccer ball and the front end of the ram. The second sub-system controls various vertical offset displacements between the centre of the soccer ball and the ram. The two sub-systems are integrated.

The design of the first sub-system uses a pneumatic DNCI standard cylinder with an integrated displacement encoder and was designed using Softstop, Festo cylinder design program. The cylinder has a

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working stroke length of 100 mm, providing sufficient displacement to compensate for the deflection of the spring so the distance between the shoe and the soccer ball is maintained.

The maintained distance, or buffer distance, is 12,6 mm. The cylinder is operated at six bar and was supplied with a guide unit used to protect against torsion. The impact energy at the end position of the cylinder did not exceed the permissible impact energy that the cylinder is designed for.

The end position controller offers fast travel between two fixed stops, which are electronically controlled with end position cushioning. The end position controller receives signals from an encoder, which is integrated into the cylinder. The controller sends out an analogue signal to the proportional valve to control the air flow to the cylinder. The end position controller is connected to a controller, which can set the stopping position.

The proportional valve has a 5/3-way configuration to provide precise pneumatic positioning that is actuated by the end position controller. The speed of the cylinder can be varied by the flow rate through the valve and the valve is controlled with an analogue voltage signal that operates at six bar.

The second sub-system uses a positioning axis linear drive driven by an integrated and controlled servo motor with a usable length of 50 mm, which is sufficient vertical displacement from the ram centre to the centre of the soccer ball. It has a mass of 4 kg acting on its guide and is vertically orientated.

An axis with 20 percent continuous loading, a motor of 68 percent continuous loading and a guide of 11 percent continuous loading was selected with a gear ratio of 6,75:1. The linear drive can handle a mass moment of inertia of 0,323 kilograms per square centimetre and the mass moment of inertia exerted on the entire axis of the linear drive was 0,024 kg/cm^2.

The horizontal positioning system was split into two sections, one governing the linear motion and the other defining the rotational movement. To achieve the required horizontal motion of the ram, a synchronous linear motor was selected. The ram is connected to a servo motor which aligns the ram to the centre of the ball after the linear motor has moved the ram to an assigned position.

The synchronous linear motors are able to traverse high loads at vast speeds and have extremely high forces of attraction that assist in high impact load forces. The synchronous linear motor is made up of two parts: the primary and secondary.

The drive operates as a rotary motor with the core as the primary and rotor as the secondary. This configuration serves as an electromagnet that meets the requirements to linearly traverse the ram with the mass that is applied to it. The linear motor is capable of reaching speeds between 1 m/s and 6 m/s.

The ram will need to move a total distance of 253,8 mm between the two end positions of the rams in order to stay in range of the goal. The primary selection was based on the total weight of the ram, including the motor that rotates the ram, the motor housing and bearings.

The primary calculations were done using a triangular operation method since the required velocity was less than the velocity of the motor. The feed force of the motor was calculated and compared with the maximum force that is available up to the motor speed.

The secondary selection was based on the travel distance of the motor, the length of the primary and the limit switch range. The major distance that the primary motor must travel is 126,9 mm from the centre of the track to its furthest position, an overall distance of 253,8 mm.

Since the combined secondary tracks provide a total length of 704 mm, 20 mm are required for the limit switches and 368 mm for the length of the primary. The total travel distance is now 316 mm (704 mm-20 mm-368 mm), which is 62,2 mm more than required. The additional length can be used for testing various goal shots.

The Movidrive drive inverter selected is able to reach a maximum force of 1 115 N and a breaking resistor was selected by calculating the cyclic duration factor. The resistor protects itself against regenerative overload by changing abruptly to high resistance and no longer consuming energy. The inverter then switches off and signals a brake chopper fault.

To rotate the ram along a horizontal plane, a DSMI swivel module would have been ideal but could not be used because its maximum working mass moment of inertia is 1 200 kg/cm2 when used in conjunction with an axis position controller.

The ram can be moved at a low rotational speed and by basing motor selection on the required torque, and keeping angular acceleration as low as possible, the mass moment of inertia of the ram and all its inclusive parts does not pose a restriction on the motor. The mass moment of inertia was calculated at 5682,524 kg/cm^2. A stepper motor was used to ensure the angular velocity remains as small as possible and a reduction gearbox was selected to accompany the motor.

The motor housing was made from square tubing with a thickness of 2 mm.

To lift and hold the soccer ball, vacuum technology was the simplest method available. A suction cup was used to lift the ball from the retrieval system to the positioning system via a linear drive. However, two suction cups were required because the weight of the ball induced a moment, which would prevent the suction cup from sealing onto the ball's surface.

An alternative method was designed to have the ball lifted by a quarter 'bowl' and have a suction cup provide support. The suction cup would provide stability so that the ball would not roll off the lifting device. A holder with a radial air supply was selected and a standard round suction cup made of polyurethane was chosen, as no thermal properties had to be taken into account.

A vacuum generator with a high suction and an integrated pressure switch was chosen as the time delay between activation of the solenoid valve was acceptable and would simplify the number of pneumatic connections and components. The vacuum generator would only be activated for a few moments before the lifting device lifted the ball.

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A second suction cup is required to hold the weight of a soccer ball and an axial holder with a height compensator of up to 6 mm was selected as the suction cup had to be flush on the surface of the soccer ball for a vacuum to be created. A non-return valve was used so that when the vacuum generator deactivated there was no loss of vacuum. The lateral force of the ram will cause the vacuum to break without affecting the trajectory of the ball.

For the retrieval system to work, the goalkeeper rolls the ball up a ramp into a nylon threaded net situated above the retrieval system. The net restricts the soccer ball, which rolls down a five degree descent though a guide. A linear drive is used to move the soccer ball from the retrieval system, via a bucket, to the vertical positioning system.

It is designed to operate at high speed because the ball is stable inside the bucket. An end position controller was selected as it allowed to intermediate positions to be programmed. The linear drive had an encoder for the end position controller to determine the position of the slide along the track and so the students selected a DGCI linear drive for this.

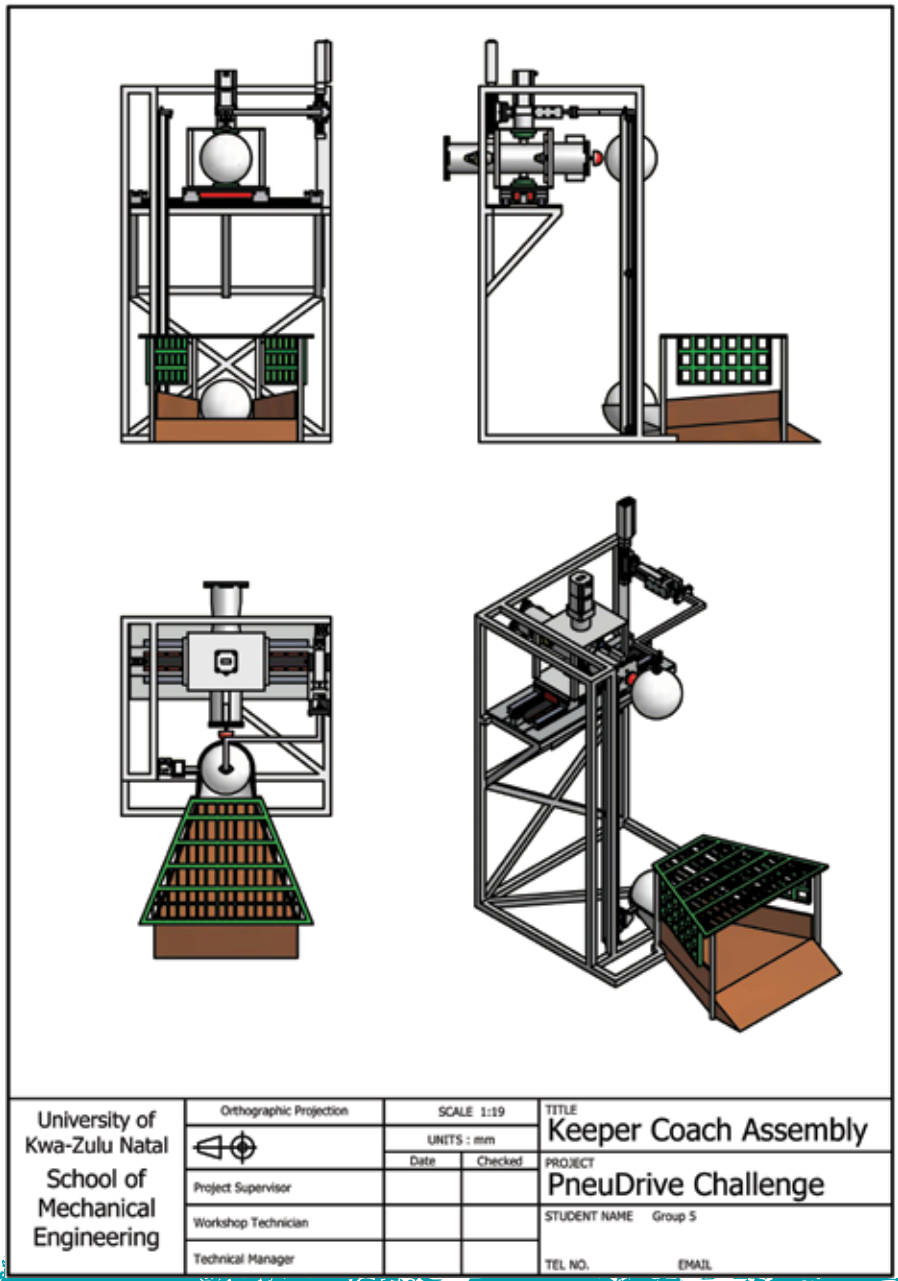
The linear drive had to have a working stroke length of 1 250 mm to compensate for the height from the ground to the centre of the goal. The bucket comprises a quarter sphere made from fibreglass and moulded to the shape of a soccer ball. The bucket is attached to the linear drive that lifts it vertically. The bucket transfers the ball to the vertical positioning system and then rapidly lowers back to its original position to await the next ball.

A programmable logic controller (PLC) connected to the valve terminal provides the necessary switching and sequencing features to operate the various components. A pressure switch is integrated into the vacuum generators to activate the solenoid valve. A controller for the stepper motor was programmed into the controller and a servo motor, used to adjust the height of the ball in the vertical positioning system also needed to be controlled by the controller.

For the synchronous linear motor, communication between the MoviDrive and the PLC was required. A CPX-FEC controller was made for the master controller to send a signal to the MoviDrive and activate the program. Various methods of cleaning the air were chosen and a regulator to control the air pressure was fitted. In order to operate the machine the sequence is quite simple. When the start button is pressed the horizontal and vertical systems are set to their home positions. The distance correction component of the vertical positioning system will be extended to a stroke length of 100 mm. This allows the operator to safely load the first ball without having loaded the ram.

The linear gantry will be set to its lowest position. Then the first suction cup will be activated and the operator will have to hold it in position until sufficient vacuum pressure is created, typically less than a second. The operator will then press the 'ready' button.

This is a safety precaution to ensure the operator moves away from the machine. Then the ram will be activated. The first shot will always be at the centre of the goal. When the ball is rolled into the retrieval system by the goalkeeper the random firing cycle will begin and the ball will be struck, each time, with a force of 1 400 Nm. To stop the cycle, the goalkeeper waits for the third ball to be fired without returning any of them to the retrieval system. With the machine empty, the 'Stop' button on the Keeper Coach will be pressed, deactivating the cycle.



Tea-bag-sized water purifier makes drinking water safe

A filter the size of a tea-bag that can clean highly polluted water may soon go on sale in South Africa. The filter costs just three cents to make and can clean a litre of water in minutes and was perfected and tested by researchers at the University of Stellenbosch.

According to Professor Eugene Cloete, dean of the faculty of science at the University, the filters are fitted into the neck of a bottle filled with polluted water.

The inside of the filter material – which is the same material used to make rooibos tea-bags – is coated with a thin film of biocides, encapsulated in nano-fibres and as water flows through it, it kills all disease-causing microbes.

The bag is filled with active carbon granules that remove all the harmful chemicals in the water. Apparently the filters were tested using water from a highly polluted river in Stellenbosch and tests showed that they effectively cleaned the water to a point where it was completely safe to drink.

Cloete, who is a past executive vice president of the International Water Association and serves as a member of Coca-Cola's worldwide panel of water experts, has worked on the invention for the past 18 months in collaboration with researchers at Stellenbosch and in the United States.

The water filter was patented in January this year. It has been submitted to the South African Bureau of Standards for testing and, once these have been completed, it will be introduced to various communities and offered for sale to people involved in any outdoor activities.

Cloete points out that a lack of adequate, safe and affordable water impacts severely on the people of South Africa, particularly those who have compromised immune systems.

Moreover, 90 percent of all cholera cases in the world are reported in Africa where about 300-million people do not have access to clean, safe drinking water.

US faces skills shortage despite producing 70 000 new engineering graduates a year

Defence and aerospace companies in the United States are urgently stepping up their support for educational programmes in an effort to get more students to choose technical careers so that they can replace the thousands of workers who are nearing retirement.

Companies are sponsoring student robotics competitions, forming partnerships with technical colleges and calling for higher national education standards in anticipation of the widespread shortage of workers in the fields of science, technology, engineering and mathematics. A 2010 study by Aviation Week magazine found that among companies that employ 100 000 people or more, at least 19 percent of employees are at retirement age and that figure is expected to jump to 30 percent by 2012 and 40 percent by 2014.

There are about 70 000 degrees in engineering awarded annually in the United States but this is simply not sufficient to replenish the work force, claims a report by the Aerospace Industries' Association.

Many of the jobs in aerospace and defence are reserved for citizens of the United States for security reasons. According to William Swanson, chief executive of Raytheon, the shortage of engineering-trained talent could pose a threat to national security because it would limit the country's ability to remain innovative.

He says his company is targeting students at mid-school level, as research indicates that if a child loses interest in science and mathematics it's very difficult to attract them back to the subject.

Raytheon has created a computer program called MathMovesU that includes an interactive website, contests, live events, scholarships and tutoring to encourage students to take an active interest in mathematics and science while at school.

How about a tea-shirt or a pair of tea-shoes?

A fabulous fashion fabric, which has the texture of leather but is extremely light, has been created by scientists at the Imperial College London for fashion designers from the Central Saint Martins College of Art and Design.

What makes the new fabric particularly unusual is that it is 'grown' in vats of tea. Fashion designers have already used it to make 'tea' -shirts, jackets, dresses and even shoes.

The fabric is grown in a soup of green tea, sugar and other nutrients over the course of several days. Bacteria is added to this solution and produces long filaments of cellulose that clump together to form thin mats of fabric that float on top of the liquid.

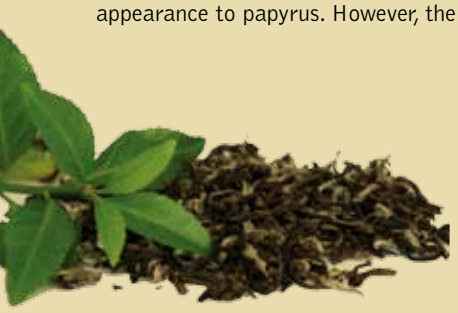
Once dried, these thin mats are see-through and similar in appearance to papyrus. However, the fabric can be treated, dyed and moulded to produce different textures and effects.

Green tea helps to encourage the Acetobacter to produce the cellulose filaments.

According to Professor Paul Freemont, a molecular biologist at Imperial College, the bacteria naturally produce these cellulose fibres but the problem is that the fabric itself is uneven.

Freemont is now working with materials expert at the same college, Professor Alexander Bismarck, to introduce the genes needed to produce cellulose sheets in other bacteria in the hope that this might increase the efficiency of cellulose production and may even lead to additional new properties being introduced into the fabric.

In its current form the fabric feels like leather, is particularly tough and can't be easily ripped or torn apart.



The Mediterranean diet to get World Heritage status?

The Mediterranean diet of olive oil, pasta, tomatoes and fish could be awarded World Heritage status by Unesco according to Italy's agriculture minister Giancarlo Galan who is pushing for this recognition.

The high-fibre, low-fat diet is believed to reduce the risk of illnesses such as heart disease and cancer and boost life expectancy. A Unesco committee is due to rule on the issue at this next conference to be held in Nairobi in November this year.

Galan says the Mediterranean diet represents a sustainable style of living based on eating local products in a convivial setting with friends and family.

Italy has been promoting wide adoption of the diet as it uses lots of fresh fruit and vegetables, pulses and beans, unrefined cereals, polyunsaturated fats and limited dairy products interspersed with small quantities of meat and sugar. Of course, if you look at the average Italian mama she certainly is seldom sylph-like and if you try telling her to use less parmesan in the bolognaise you'll probably get a sharp clip across the ear, but be that as it may.

The basic diet has variations but it is common to Italy, Greece, Spain, Portugal and Morocco. If the diet is approved as a World Heritage diet it would do much to promote the traditional Mediterranean methods of preparing and cooking food.

Apparently the Italians are extremely concerned that low quality copies of their best-known foods – such as prosciutto ham, extra virgin olive oil and mozzarella cheese – are being made in other countries and passed off as the genuine article.

If successful the Mediterranean diet will be included in a sub-section of World Heritage List known as the Intangible Heritage List, which has already been awarded to historical monuments such as Stonehenge and Angkor Wat. Nearly 180 different cultural treasures have been included on the Intangible Heritage list in the last two years, including folk songs, endangered languages, religious rituals and traditional crafts.

To me it sounds like a marketing exercise dreamed up by marketing gurus over a bottle of Grappa somewhere in the United States. But that's just the cynic in me.

Note: Voluntary associations registered with ECSA can apply to the SAIEE to allow their members to gain credits at the reduced rate.

Enrol now for the WATTnow CPD Programme by filling in the form below.

SAIEE members pay just R1000 annual subscriptions fee

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Can you make petrol from carbon monoxide?

An enzyme that is commonly found in soil bacterium could be used to manufacture an environmentally friendly fuel. The Azotobacter vinelandii microbe found around the roots of various food plants creates the enzyme vanadium nitrogenase, which in nature produces ammonia from nitrogen gas.

Now it has been shown that the same microbe can create propane, (a fuel used in camping stoves), from carbon monoxide. Carbon monoxide is a largely unwanted by-product of many industrial processes.

According to Markus Ribbe, a scientist at the University of California, the enzyme could be tweaked so that instead of only making the simple three-carbon-atom chain molecule of propane it could create longer chains that make petrol.

He believes this could lead to new synthetic liquid fuels being made in industrial concerns around the world.

Ribbe says that when deprived of the oxygen and nitrogen from which it made ammonia, and given carbon monoxide instead, vanadium nitrogenase started using it to produce short carbon chains just two or three atoms long. Ribbe says this was a profound discovery.

Cars produce carbon monoxide in the exhaust gases through incomplete combustion so it might be possible to use this carbon monoxide to ultimately make more petrol, using the tweaked enzyme.

But Ribbe is quick to point out that extracting, growing and storing sufficient quantities of vanadium nitrogenase is very difficult. Moreover, while A.vinelandii and its useful enzyme have been known for about 20 years, the technology to make it in useful quantities is very new.

So while it's not possible to make petrol from carbon monoxide yet, it may soon be possible to do so and, usefully, it may also be possible to take carbon monoxide out of the atmosphere, transform it into petrol and put it back there again.

A whole universe inside a black hole?

A Polish cosmologist has adapted Einstein's Theory of Relativity and analysed the theoretical motion of particles in a black hole and speculated that entire universes could exist inside each black hole. Furthermore, our universe could also be inside a black hole.

Of course nobody can prove his theory because, at this stage anyway, nothing can get out of a black hole, not even light. However Nikodem Poplawski is not concerned by his inability to prove his theory.

Explaining it in an article published in the journal Physics Letters B he says he used the Einstein-Cartan-Kibble-Sciama theory of gravity in his analysis to account for the angular momentum of particles in a black hole.

Doing this allowed him to then calculate a quality of space-time called torsion, a property that is thought to repel gravity. He says that instead of reaching infinite density or singularities in a black hole, the behaviour of space-time is more like a spring being compressed with matter expanding and rebounding continuously.

The bounce-back effect, he says, is caused by the torsion of space-time having a repulsive force against the strength of gravity in a black hole. He claims that this recoiling effect could be one of the reasons that the universe we observe today is flat, homogenous and isotropic. Dr Poplawski theorises that if we were living in a spinning black hole then the spin would transfer to the space-time inside and this would mean that the universe would have a preferred direction that could be measured.

He says that such a preferred direction could be related to the observed imbalance of matter and anti-matter and could explain the oscillation of neutrinos.

But how would we ever know?

CPD Overview

WATTnow, in conjunction with the South African Institute of Electrical Engineers (SAIEE), has launched this programme for engineers who need to meet their professional development commitment by securing Continuing Professional Development (CPD) credits. In terms of the renewal of registration requirements, all professional electrical engineers must earn five CPD credits a year. Failure to certify CPD credits could jeopardise renewal of their registration.

WATTnow publishes articles in each issue that qualify readers for Category One CPD credits, which require engineers to respond to in-depth questions posed on articles that are specially designed and validated to provide CPD. Engineers using the system will accumulate between 0.1 and 0.3 CPD credits if all the questions are answered correctly. Ten such articles are published annually so at least one CPD credit can be obtained by this method. The articles in **WATTnow** are independently validated by the SAIEE, which determines the exact value of each credit applicable to each issue of the magazine.

In future, **WATTnow** will produce a series of video broadcasts of up to six lectures annually on topics that have been validated for CPD by the SAIEE. These lectures will be filmed and edited by a **WATTnow** production team and converted to either CD or DVD disks before being distributed free-of-charge to members of the **WATTnow** CPD Programme.

A series of appropriate questions will be included on the CD or DVD and members of the programme can submit their answers directly to **WATTnow** by e-mail, on-line or by fax. The filmed presentation will qualify the user to claim credits in the Category One section, which makes attendance of a conference at least once a year mandatory.

The SAIEE will issue each member with an official certificate recording the exact number of credits gained by each individual in any given year.

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.

This 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 for sufficient credits to meet the ECSA requirements.

For further information visit www.wattnow.co.za

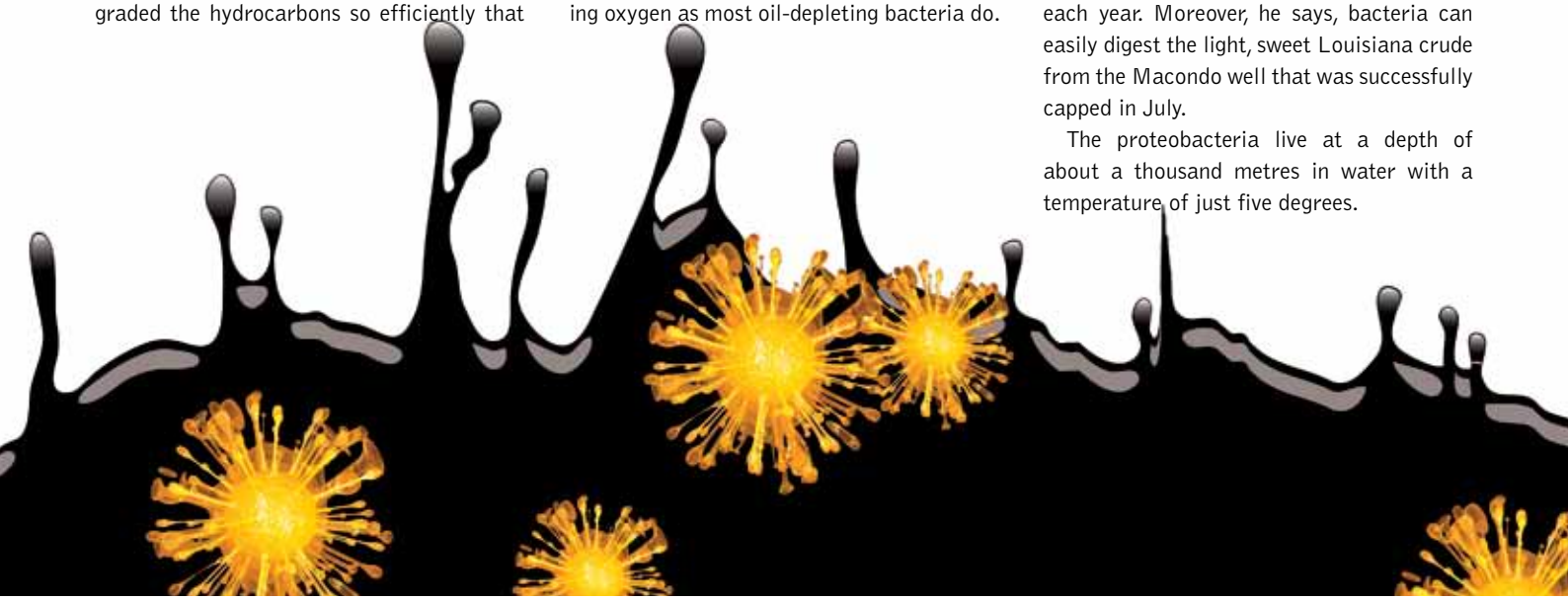
Oil spill eaten up by microbes

As BP's broken oil rig spewed millions of litres of crude oil into the Gulf of Mexico – with devastating consequences for marine life and the environment – scientists discovered a fast-eating species of microbes that started consuming significant quantities of oil. The microbes may have been stimulated by the huge oil spill at BP's Macondo well that began in April. The microbes degraded the hydrocarbons so efficiently that the oil plume that was the size of Manhattan is now undetectable.

According to Terry Hazen of Lawrence Berkeley National Laboratory, these proteobacteria have adapted to the cold, deep water where the BP oil plume was observed. The microbes were able to break down the hydrocarbons much more quickly than had been expected without significantly depleting oxygen as most oil-depleting bacteria do.

Oxygen in the water is essential for the survival of commercially important fish and shellfish stocks in the Gulf. This is compounded by a seasonal low-oxygen 'dead zone' that develops in the Gulf when run-off from farm chemicals flow down the Mississippi River to the ocean. Hazen says that natural oil seeps into the Gulf of Mexico all the time, pushing out the equivalent of an Exxon Valdez spill each year. Moreover, he says, bacteria can easily digest the light, sweet Louisiana crude from the Macondo well that was successfully capped in July.

The proteobacteria live at a depth of about a thousand metres in water with a temperature of just five degrees.



Self-cleaning system for solar panels

A self-cleaning system for solar panels – that was developed for the Mars Rover – could be used to increase the efficiency of solar panels here on Earth according to scientists at the National Aeronautics and Space Administration.

The Rover has built-in sensors that detect dust build-up and when this happens, it emits an electrical charge to disperse the dust and keep the panels clean. According to Dr Malay Mazumber of Boston University, a dust layer of just four grams per square metre decreases solar power conversion by 40 percent.

He says that dust deposits in Arizona are about 16 grams per square metre and this seriously limits the efficiency of the solar panels there. The deposits are apparently even higher at solar power plants in Australia, the Middle East and in India.

Mazumber worked with Nasa scientists to create the self-cleaning system that has been successfully used on the Mars Rover since 2004. It involves coating the solar panel surface with electrodes of Indium tin oxide, a transparent, electrically-sensitive material.

Sensors monitor dust levels on the surface of the panel and energise the material when dust builds up to a critical level. Electrodes on the panels produce a cascading wave of electrostatic pulses, which shake off the dust, leaving the panels clean and more efficient. Mazumber says the process removes about 90 percent of the dust during the two-minute cleaning cycle and uses just a small amount of electricity for cleaning purposes.

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.

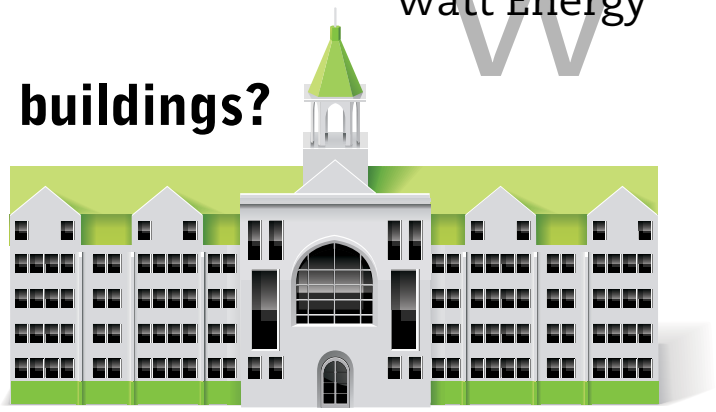
The mentor could recommend to the mentee what course of action to take without being too prescriptive while the final decision and the consequences remain with the mentee.

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 that you have the time and interest to help mentees, please contact Ansie Smith on smitha@saiee.org.za or 011 487 9050,
In addition you gain CPD credits, for when you are required to re-register.

Solar panels for public service buildings?



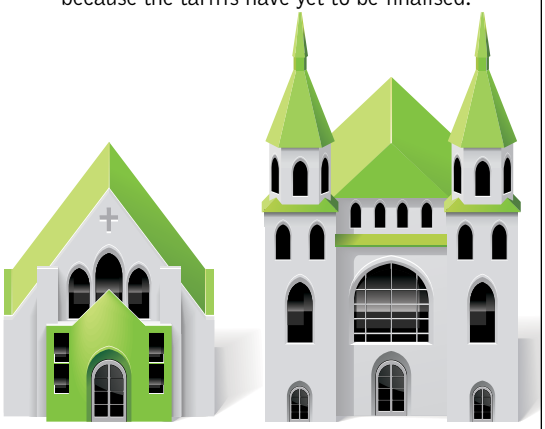
The British government is planning to install solar panels on the roof of every public building in the region and put up wind turbines in hospital car parks as part of a plan to earn £100-million a year generating electricity from renewable sources.

Until now, councils in the UK were not allowed to make money from installing renewable energy schemes as there were fears they might upset the electricity market. But this is set to change with the new feed-in-tariff that allows councils and individuals to feed electricity into the national grid and get paid for it.

Current estimates indicate that the average town hall, with solar panels on the roof, could earn about £10 000 a year supplying electricity to the national grid. Another estimate shows that a 40-metre-high 1 MW turbine erected in a windy leisure centre car park could generate electricity worth £160 000 a year.

Councils that install anaerobic digesters or incinerators that generate electricity from waste will not only reduce the amount of waste they have to contend with but will also make money by providing electricity to the national grid. Chris Huhne, the Energy and Climate Change Secretary says that councils in England and Wales alone could earn about £100-million a year. This money could be used to cut taxes for ratepayers in the UK.

There is no indication at this stage of what the councils will be able to charge for the electricity that they provide to the national grid because the tariffs have yet to be finalised.



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Hi Paddy,

The article "Sunshine and Sewage", in **WATTnow**, June, raises some very interesting points. There is nothing really new about the proposals, taken individually, but the attempt to combine them into one scheme seems to be novel. I have one reservation, however: Is not getting a trifle too complex to be seen as a practical option?

While the project is under the control of CSIR, all the necessary scientific and technical know-how is readily available "in-house", but when installed at some remote location in its practical incarnation this may not be the case, since the availability of even basically-qualified Engineering staff at a municipal level is known to be one of the major crisis points in the current SA situation. Since this scheme brings into play a combination of operating chemical plant, electrical plant and some form of waste-heat distribution, it seems that a great number of different disciplines will need to cooperate for successful management of the system. Such staff is in extremely short supply today. Some municipalities are reported as currently being unable even to operate a conventional sewage-processing plant correctly.

The discussion of costs seems a little incomplete. The reference to this scheme costing around R24-million a year, compared to R2-billion for the pebble-bed reactor omits to mention a difference of scale. This scheme is targeted at the capacity of a 600 kW generator, whereas the PBMR was looking at some hundreds of Megawatts for a single system; on the other hand, the overall time-scales involved in the implementations are significantly different. The uptake of the waste heat output seems somewhat vague, and presupposes some form of industry that can be fed with this energy. In Northern Europe, where the density of housing is much greater than in suburban SA and local temperatures are often lower, schemes for community-level domestic heating are sometimes envisaged, but that option seems unusable here.

I am awaiting the final results with great interest.

Regards
Tony Fisher

Hi Paddy

I am an avid reader of WATTNOW and especially the comments from you and my colleagues in the industry.

In my dealings with brand new engineers just out of college I have observed that while the technical aspects of their education are adequately dealt with, many of them have difficulty putting this into practice. They just don't know how to approach a job and how to evaluate the problem.

Many years ago, we who attended the old Heidelberg Army Gymnasium, to be trained as junior leaders in the infantry, were taught a method to use in rapid problem solving.

I decided to adapt it and inflict it on some of the younger guys around here. I think others may benefit from this.

If you see fit, you are free to publish it and change it as you wish.

PHILOSOPHY OF PROBLEM SOLVING GD CARTER, WSP

Many of us are unable to solve problems on our feet quickly.

If you are one of those blessed with the ability to do so, you can ignore this.

For those of you who, like me, struggle to get going, here is a well tried and tested method which will help.

You may not have heard of General Tsun Tzu.

He was a famous Chinese General in the 6th century. He was faced with the problem of defeating Ghengis Khan.The bulk of his army consisted of Chinese peasants. He needed to produce people who were capable of taking rapid decisions under extreme pressure, very quickly. There is nothing more compelling than when you are about to have your body cleaved in half and having to make the correct decision on which way to jump.

This method is what is known as a top down approach and is used iteratively. At each iteration answer the question only in sufficient detail to be able to go to the next level of decision making.

Do not get blinded by analysis paralysis and make the mistake of trying to fill in too much detail.

Answer the following questions:

WHAT am I going to do?

WHY am I going to do it?

WHEN am I going to do it?

WITH WHOM am I going to do it?

WITH WHAT am I going to do it?

and then

WHAT THEN?

This method will allow you to formulate PLAN A, while hatching PLAN B at the same time. PLAN B is the WHAT THEN.

If you think this is nonsense, let me drop some names on you. Nelson, Napoleon, Bismarck, Montgomery, Rommel, Yamamoto, Bull Halsey, Patton, Branson and many more.

All are (or were) successful leaders and all shared in the works of Tsun Tzu.

For the propeller heads among us who think that an MBA is a good way to waste three years and R100 000, this method does all of the following at once:

Thinks out of the box, does so at Grass Roots level, touches base and repositions the paradigm.

Try it! Trust me, it works as Tsun Tsu and his peasant army proved it by defeating Ghengis Khan twice.

Regards
Geoff Carter
Head of Department
Chief Electrical Engineer
Associate

Global warming – can we continue to ignore it?

By Ian Fraser, managing director of Tshwane-based Rand Technical Services

Few of us are unaware of the worldwide concern about global warming. Scientists, politicians and ordinary people have vastly different views on global warming. While the science behind the climate change threat is widely accepted in scientific circles, the sceptics present data that claims to be scientific but often fails on close scrutiny. The evidence for climate change is based on a vast amount of data that ranges from the indisputable to indicators that may or may not be accurate. The sceptics point at the uncertainties and use these to discredit the entire line of reasoning. Of course, this is not helped when we discover that prominent scientists have actually falsified data (this accusation was made and sustained in England recently).

But this is not a zero-sum argument. By proving data or a statement faulty, an entire body of evidence is not necessarily discredited. What we have to ask ourselves is: 'Is it likely that global warming is occurring?' And: 'What does the available evidence say about it?'

There is a vast amount of evidence confirming that global warming is indeed a very real threat. But there are also anomalies suggesting there may be something wrong with some of this evidence. Now, at what level of risk do we simply laugh the consequences of global warming off? If only half of the data is correct then there is a 50:50 chance that global warming presents a real risk. Should we then ignore it and hope for the best? Or should we decide that the risk is great enough to do something about it? The answer has to be the latter.

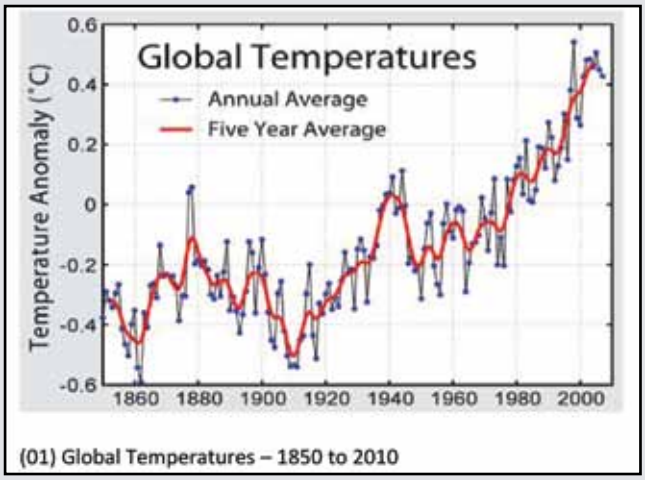
We know that human activity contributes significantly to the warming of our planet. We need to look closely at some of the arguments presented by those who are convinced that there is no problem:

Global warming is natural – it has happened before: This is true. There have been events over the millennia with significant increases in atmospheric gas loads – including carbon dioxide (CO2), significantly at the end of the Cretaceous – early Palaeocene era. Does this lend itself to a strong argument against global warming? No, it does not.

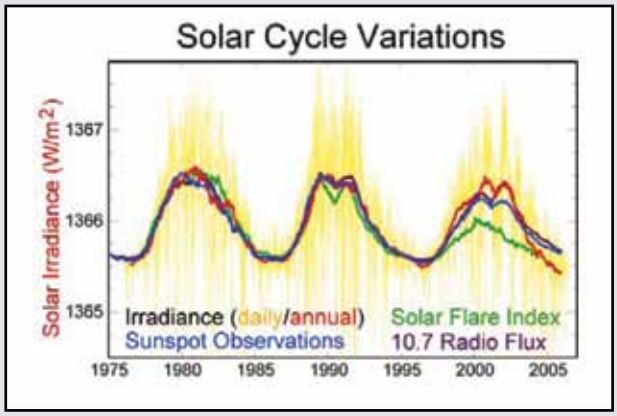
It is a fact that the Palaeocene event resulted in widespread extinction – including the demise of the dinosaurs.

It is also worth noting that, over the last 500 000 years, carbon dioxide cycled only between 180ppm and 280ppm. The means global temperature has followed this and cycled through a range of about 10°C. We are now at 380ppm – and climbing. Global temperatures are not rising. Since 1998 the average global temperature has dropped: Yes temperatures have dropped, but this is part of the normal temperature cycle that is superimposed on the long term trend. (See Graph 01). The graph also shows that the temperature also dropped regularly for short periods (1940 to 1947 and from 1961 to 1964,) as it did during numerous other periods. Nevertheless, the overall trend is inexorably upwards and there is a strong correlation between this rapid rise and human industrial activity.

The increase in global temperature is due to sun spot activity: This is simply not true. Look at the record of all sun activity including solar flares, irradiance, and radio flux (see Graph 02). The cycle is constant and repeats every ten years or so. There is no sign of an overall increase, or decrease. There is no correlation whatsoever between the activity of the



(01) Global Temperatures – 1850 to 2010



sun and global warming. The short cycles (grey line in Graph 01) do seem to be linked to sun activity – albeit rather loosely, but other factors are obviously having a stronger effect..

Mankind is puny and there is nothing man can do to affect a huge system like this planet: Really? This seems to be based on the potential within nature for huge cataclysms larger than anything man can achieve. There is no logic in extending this argument to the reasoning that man cannot affect the planet. Supporters of this argument often quote the carbon dioxide emissions from volcanoes, which they claim are many times greater than any man-made emissions. This again is simply not true. Consult a wide range of sources, and you find that estimates of volcanic carbon dioxide emissions vary from about 100-million tons a year to 250-million tons. Human activities contribute about 28-billion tons a year. So, in fact, no matter how much 'error' you want to assume in the numbers, volcanic emissions are miniscule compared with those generated by human activity.

It is true that natural contributions of greenhouse gas from degrading biological mass are magnitudes larger than any human contribution. But, the planet can, and does, have mechanisms to absorb most of these emissions. In fact there is some slack. It is estimated that some 57 percent of human generated emissions are absorbed by the ecosystem. That leaves 43 percent that are not absorbed, and these add to the increased load of greenhouse gas in the atmosphere. The point that we are upsetting a balanced system and drawing comfort from comparisons with the overall volumes involved is simply not logical.

Meanwhile, we ignore the fact that the real threat to survival on this small planet is endless population growth and the perceived necessity for economic growth. This results in vast quantities of waste and pollutants, including carbon dioxide, generated and emitted in ever-increasing quantities. Do the sceptics really believe that it does not matter? Economic growth can be generated by only two mechanisms. Increase in the population (more consumers) or economic upliftment of the existing population (more consumption by existing consumers).

To put this in perspective, let us just look at carbon dioxide within the human context. Each consumer at middle class level in the world contributes about 30 tons of carbon dioxide a year to the atmosphere. The figure for the entire population of the planet is currently about four tons per person per year, which includes subsistence farmers who contribute very little. Whether you think that the activities of humanity are contributing to global warming or not, consider this: if the population stops growing at seven billion, and all further economic growth is generated by economic upliftment, eventually each person on this planet will be generating about 30 tons of carbon dioxide a year. This is a total of two hundred and ten billion tons of carbon dioxide annually.

If you consider that the total contribution of humanity today is only about 28 billion tons, and carbon dioxide levels are climbing – whether you accept that they are causing present global warming or not, the conclusion is inescapable; we are heading for a big problem. Add to that all the other stuff we generate: nitrates, various sulphur compounds, and dozens more.

Please note, none of this is based on questionable research or unreliable measurements. This is simple arithmetic based on accurate (and unchallenged) measurements.

As J.K Galbraith pointed out 40 years ago: "Man has developed an obvious capacity for surviving the pompous reiteration of the commonplace". We need real solutions to real problems. If we think the problems are exaggerated we need to study the entire picture and not just latch onto data that matches our preconceptions.

It is essential that we achieve a sustainable balance between human activity and the environment. This will require the adoption of green technologies (including nuclear power) and a limitation on population growth, which is best achieved by education and economic upliftment. This can only be achieved by adopting environmentally neutral policies that will have to start with sustainable farming methods – including genetically modified crops, through to carbon neutral energy such as solar, nuclear, and others.

If we do not take the time to take a really unbiased look at how we live and take whatever action is appropriate, any chance we do have to control our destiny may well be lost.

The South African Institute of Electrical Engineers
"Dedicated to the interest of professional Electrical and Electronic Engineering in South Africa"

Riversdale power station preserved

By Les Stuart

When the Eskom power distribution network eventually reached the southern Cape town of Riversdale in 1975, the local municipality was faced with a decision regarding the fate of the power station that had served the town so well since 1924.

The original DC generators were in service until 1958, when new developments and expansion dictated the need for a larger AC power generating facility, and a new building was erected to accommodate the power plants, switchboards and associated equipment.

An 8-cylinder Liston Blackstone 375 kVA generator and a pair of Ruston & Hornsby 187,5 kVA units were installed, all of which are still in position, and only one of the Rustons is not presently in operational condition.

A large English Electric generator was ordered from England, and was shipped out on the ill-fated Seafarer, which struck the rocks at Green Point, within walking distance of Cape Town harbour, and the equipment was lost. As a new replacement would not be available for some time, an alternative unit was purchased from Middelburg, Cape, and installed in the new building, where it still remains operational today. The massive V12 engine drives a 1600 kVA 6,6kV alternator.

Once the town was provided with Eskom power, the municipality resolved that the redundant power station equipment should be sold. Indeed, a number of smaller supplementary generators and other equipment were subsequently sold, but at such modest prices that the decision was revoked, and the station was retained as an emergency standby supply for important parts of the town. This has proved invaluable during the Eskom energy supply crisis, and during scheduled maintenance outages.

The power station is under the meticulous control of Gert Mans, who was to have retired a few years ago, but has fortunately been contracted to continue with management of the station, on which he has worked for over 40 years!

During a recent visit, he proudly ran up both the English Electric and the Lister Blackstone machines, and his intimate knowledge of the temperament of each plant was clearly demonstrated.

It is certainly encouraging to see that, with knowledge, experience and dedicated care for elderly equipment, it can continue to serve a valuable purpose for a considerable time to come.

Lister Blackstone generator.

Ruston Hornsby generators.

1958 Building.

Gert Mans starting the Lister Blackstone.

What's the Historical Section of the SAIEE ?

In May 1979 a small group of enthusiastic and dedicated members of the South African Institute of Electrical Engineers agreed that steps should be taken to collect obsolete electrical equipment and preserve it for posterity. They called themselves the Historical Interest Group of the SAIEE (HIG) and set about collecting, identifying and storing numerous items which they considered to be of historical value and likely to be of interest to future generations of engineers.

The number and size of items grew quickly and created a storage and display headache. Fortunately Eskom was able to offer storage space close to the Johannesburg CBD in an unused section of the old Robinson Substation. With the Institute's move from Kelvin House to Observatory further space was allocated in the outbuildings at Innes House and a portion of this has since been developed as a library.

Twenty three years later, in August 2002, the Institute's Council decided that the work of the HIG justified full Section status and the HIG became known as the Historical Section (HS).

Its activities are carried out by a small group of volunteers drawn largely, but not exclusively, from the ranks of retired members. The work consists mainly of weekly work sessions at Observatory, during which books and artifacts are sorted, identified, catalogued and displayed. Visitors are given tours through the facility, and over the years the Section has organised talks, visits and demonstrations of various kinds.

A recent event commemorated the 50th anniversary of the development of the Wadley Tellurometer. This remarkable survey instrument was developed at the CSIR by one of our former members (Dr. Trevor Wadley) and revolutionised the way land surveyors measured distances. The instrument is still in use in mining even though GPS systems have largely taken over the original function. One of the prize exhibits in our collection is Wadley's prototype Tellurometer and we also have many other types of early instruments, lamps, valves, radios, computers, recorders, telephones and other items. Another important part of the HS committee's responsibility is the development and maintaining of a national "virtual" museum. This can be found on the Institute's website and displays a variety of items from the collection, as well as write-ups on some pioneers of our local electrical history.

They also assist in the preservation of historical items in situ by placing a small plaque on or near the item. Appropriate wording draws visitor's attention to the importance of the object or site. One such item is the shack in Irwell Street, Observatory, Cape Town, from which the first public radio broadcast was made in 1919.

The chronic shortage of display space was one of the driving forces that led the SAIEE Council to embark on an exciting new development on the Observatory site and 2011 will see the current Innes House administrative staff being re-located into a new building on the site, and the Historical Section will then take over Innes House. This will provide a new and much improved location for the library and an ideal display centre for the museum. Additional storage space has also been included in the design.

The challenge of identifying themes and equipment for displays has raised a new enthusiasm and excitement among the committee members and a recruitment drive is soon to be made in order to attract Institute members to assist in identifying possible themes for future displays, and designing them in a way that will attract visitors to the museum and provide educational opportunities for students and younger visitors.

Any reader with a talent or interest this field is welcome to join the team and help us make a difference. This may be the start of an exciting new interest and activity in your life..! Why not find out more by contacting the Institute's offices at telephone 011-487-3003, or telephone the HS Chairman, Max Clarke, on 011-476-5925.








University of Cape Town IEEE PES Chapter Launch

The University of Cape Town (UCT) launched its second student technical chapter the IEEE Power and Energy Society (PES) Student Chapter.

The event was honoured by the presence and presentations of the IEEE's Matt Loeb, executive staff – corporate strategy and IEEE's power and energy society president, Alan Rotz. Also in attendance at the function was IEEE PES executive director Pat Ryan.

The event was opened by the university's electrical engineering head, Prof. Jonathan Tapson. He spoke about the energy research initiatives undertaken by different research groups within the university.

He was followed by Matt Loeb who spoke about the IEEE, its activities in developing countries and its importance to electrical engineering professionals before PES president Al Rotz's talk on sustainable energy alternatives in the USA. His talk took the audience through the various types of sustainable energy, and all the different sources and applications. His presentation highlighted the fact that sustainable energy will be a mix of diverse energy sources. The last speaker was UCT IEEE student branch chair, Joyce Mwangama, who gave a brief overview of the student branch's initiatives and ambitions. Her talk highlighted the activities of the branch in terms of members, events and projects. One such project is the EPICS-High project that is run by the projects committee. Matt Loeb, Alan Rotz and Pat Ryan promised to support the project in future.

Additionally, Loeb and Rotz presented the branch's WIE student affinity group with the IEEE honourable mention award (2009). Manuella D'Oliviera Pio received the award on behalf of the affinity group.

Overall, the launch of the student chapter succeeded in enlightening the attendees, who consisted of university staff, students and guests from industry, and gave the visitors a glimpse of the running of the University of Cape Town IEEE Student Branch.

Thanks also to the SAIEE for providing assistance with the event.

Student branch committee members, lecturers and guest speakers after the event

Prof. Jonathan Tapson, Alan Rotz, Matt Loeb, and Pat Ryan.

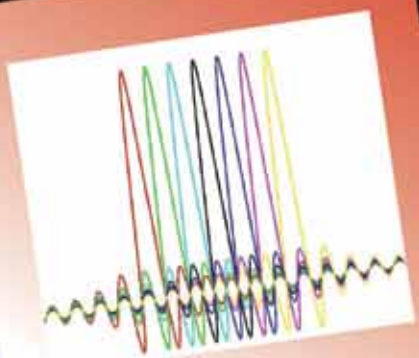
Students and Lecturers in attendance.

TELECOMMUNICATIONS RESEARCH GROUP

POWER LINE COMMUNICATIONS:
University of Johannesburg

Our Research Interests

Powerline Communications
Digital Communications
Coding Techniques
Information Theory
Video Communications
Networks



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