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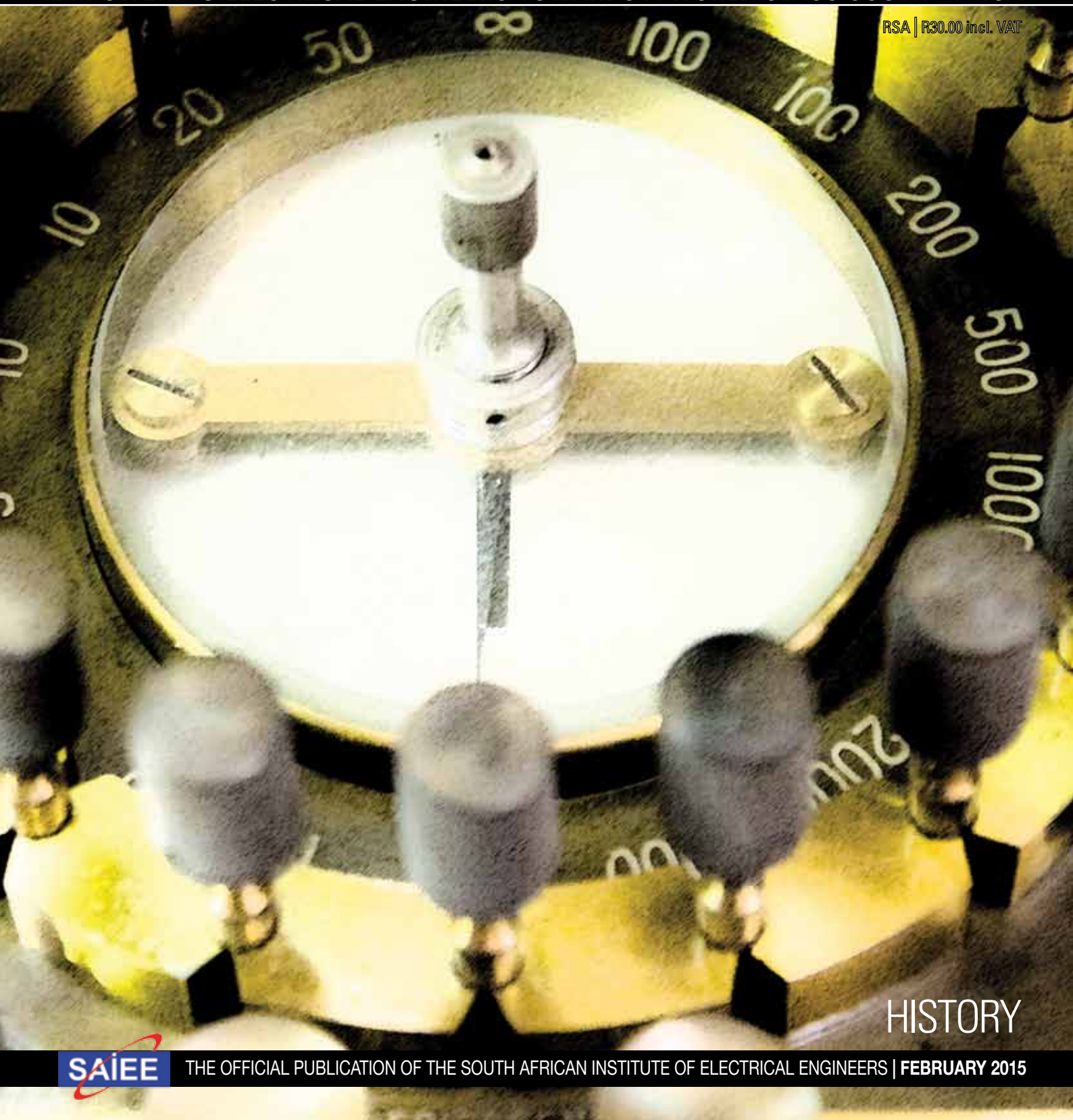

HISTORY

SAIEE THE OFFICIAL PUBLICATION OF THE SOUTH AFRICAN INSTITUTE OF ELECTRICAL ENGINEERS | **FEBRUARY 2015**

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February - alas - the month of L.O.V.E.! Gentlemen, yes Valentine's Day is on the 14th of Feb, do not forget to buy your partner a box of chocolates. I did my research: chocolates are made from cocoa beans, which grows on trees. This then can be classified as a fruit, and we all know fruit is good for you!

On a serious note - the February issue features around history and instrumentation. The members of the Historical Section (HS) have aptly written a few articles for this issue. You can find the introduction on HS on page 24.

Richard Dismore, member of HS, wrote an interesting piece on Greg Roberts, who is a legend living amongst satellites. This you can find on page 36.

My 'staatmaker' Dudley Basson has written two beautiful articles, one on Dr Hendrik van der Bijl (pg 26) and an article on the history of Colour (pg 44) - imagine what life would've been without colour.

WATT? is our new regular feature where we have your industry questions answered by experts. You can send me your questions anonymously (if you prefer) to minx@saiee.org.za. This "Expert Advice" column will only be a success with your participation, so I implore you to send me any questions you might have, which are industry related.

Herewith the February issue - enjoy the read.

Minx

"Chocolate is nature's way of making up for Mondays."
- Anonymous

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*Visit www.**watt**now.co.za to answer the questions related to these articles to earn your CPD points.*


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Greetings to all our Members from SAIEE House, Johannesburg

Our journey towards World Class South Africa gathers momentum. Let us continue to walk hand in hand as we charter the next steps during 2015 and onwards. Let us add urgency in establishing all our working platforms, from student chapters, to corporate partners, to associated societies locally, regionally and internationally. Let us get all our student chapters at the universities of research and technology, and at our own community high schools fully operational. Let our focus be intensive in growing our membership in engineering, science and technology. Let us enroll every corporate entity as our corporate partner. Collectively, we can achieve the World Class South Africa much earlier. Thank you for your continued membership of the Institute and for your voluntary contribution. Much appreciated.

Let me share with you my own stories of 2014. The Institute continues to grow me from strength to strength and has delivered consistently since the start of my engineering career in 1977.

2014 has delivered three platforms of leadership for me. These platforms emanated directly from my presence and activities at the Institute. You may call it my declaration of interest.

My first appointment was in the private sector. My private consultancy has grown in strength from a one-engineer specialist output to that of a Director on the Board of a South African registered EPC/M Company. My one-man consultancy had a structural gap. The gap was access to resources for engineering projects. Resources in the classical business school terminology refer to manpower, money, machines and materials. In April of 2014, I was invited to meet with the Tata leadership in New Delhi, India. This meeting delivered for my consultancy a shareholding and a seat on the newly established local company Board. We are in the early days of establishment and a first key output is to "grow our own timber".

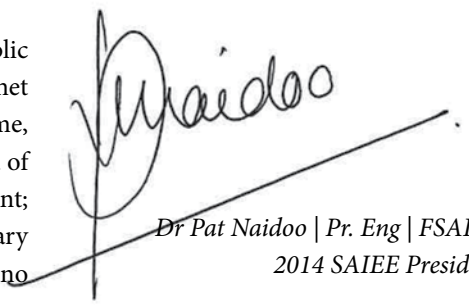
My second appointment was in the academic sector. I regularly go out of my way and participate in extracurricular activities with academia. My drive is to always share my experiences with the students and grow their appetite for further study, test, research and investigations. This activity delivered for me a close working relationship with the Durban University of Technology; in particular, and all South African universities, in general. In April of 2014, the University Council appointed myself as Adjunct Professor of Power Engineering at DUT. My workings have commenced and we are pushing ahead to gain our seat amongst the global community of electrical engineers.

My third appointment was in the public sector. In December of 2014, the Cabinet of the Republic of South Africa invited me, as your President, to serve on the Board of Eskom. This was our Christmas present; received and opened by our Honorary Fellow, Dr. Ian McRae. Our joy was no different to that of the little ones who opens their presents on Christmas morning. We communicated our appreciation to the President, Minister of Public Enterprises, Chairman of the Board of Eskom and the Chief Executive for the call up to national duty. Our discussions on "Electricity South Africa" went from the Council Chamber and straight into the Boardroom of Eskom.

Our clear understanding is that the super thermal power stations, as represented by Duvhas 6 x 600 MW, built in the seventies, requires maintenance plus (more like refurbishment). The "firebox" has aged. This is no fault of Eskom, of any employee or of any stakeholder. Most of the Eskom fleet performs in the world-class performance ranking, and several of Eskom's power stations and generating units are rated among the best in the world. This excludes the bulk of the eight super thermals. Their size and importance in the power system impacts directly on energy availability and directly contributes to load shedding and the negative sentiments towards Eskom.

This is not acceptable. Let us help and change this state of the nation. I want a new conversation with all our members, with all the engineers of South Africa and with all our communities and the public. It is our duty to work with Team Eskom and South Africa, and return Eskom to its rightful place: World's Best and the African Power House.

Hope you are now settled in your work and have commenced your further studies in engineering test, investigations and research. Time is free. Walk confidently and be the best in the world.



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WATTSUP

SA's Jeanri is World's First Female Snell Thermography Instructor

Comtest, leading local provider of test and measurement and process control equipment solutions from world leading manufacturers to the southern African market, has proudly announced the inclusion of Jeanri Mellanby into the ranks of The Snell Group's (TSG) instructor cadre.

Mellanby, with Comtest Technologies in Johannesburg since 2007, is the first woman worldwide to become a certified Snell Thermography Instructor. She is also one of only seven women worldwide to have attained Snell Level III Thermography. Mellanby has trained with TSG's American infrared expert, Ron Conner since 2013 to become a Snell Authorized Licensee.

Jim Fritz, TSG's President/CEO says, *"We are very pleased to welcome Jeanri as a TSG Instructor. All her hard work and efforts have paid off, as we recently authorized Jeanri to present Level I courses independently, as a Snell Group Authorized Licensed Thermography Trainer. As it stands today, there are five Level I and one Level II classes scheduled to be presented by Jeanri over the next 14 months in Johannesburg. We hope that many would-be thermographers will have the opportunity to work with her in person, both in South Africa as well as in the USA".*

Mellanby's exposure to infrared began in 2005 at an electrical contracting company where she conducted full-time electrical and mechanical inspections. A few years later she included building and equine inspections. With Comtest, she has undertaken a wide variety of inspections for a broad base of customers throughout southern Africa.

She has also written several papers, and presented them at various SA conferences. The next IR Thermography Level I course will be held in Johannesburg from 16 - 20 February 2015. For more information contact Jeanri Mellanby on 010 595 1821 or email: sales@comtest.co.za.

Jeanri Mellanby
TSG Instructor

Schneider launches three-step Smart Panel

Schneider Electric has announced the local availability of a Smart Panel system that will assist in fostering sustainable energy savings in small to mid-size buildings, such as public and commercial offices, retail premises and hotels.

Founded on Schneider Electric's energy management principle of "measure, understand and save", the Smart Panel is an easy-to-deploy solution that addresses the urgent need to cut energy costs and meet regulations for green buildings.

"Measure and collect" is the first step, with the automation of energy consumption metering at source. It not only simplifies daily operations, but also eliminates the traditional error-prone manual data gathering.

The second step, "collect to understand", is enabled by the Energy Server Com'X 200, a smart data logger that gives timely and secure access to the consolidated energy data.

As facility managers need access to energy analyses to execute the third step, "understand and save", Schneider Electric says that its StruxureWare Energy Operation service helps deliver energy savings and identify areas for continuous energy efficiency. As a cloud-based Software-as-a-Service (SaaS) solution, Energy Operation is cost-effective and users have access to the tailored-to-audience reports from anywhere and at any time for informed actions in order to meet energy goals.

Documenting South African Radar

The November 2014 issue of **watt**now carried three remarkable stories on the development of radar in South Africa and its use and deployment during WW2.

With the cessation of hostilities in 1945 the highly secret Special Signals Service's team, which had been responsible for developing the local equipment, was disbanded.

Fortunately Dr. Basil Schonland, the leader of the original team, recognised the importance of recording as much of the story as possible and requested "Boz" Bozzoli – a key member of the team from the very first days in 1939 – to document as much detail as he could for posterity.

This was duly carried out and a large "book" which included numerous pictures and descriptive text was produced. It is not clear where the book was initially kept but it eventually came into the possession of Dr. George Walker, a colleague of Bozz's, and was eventually kept at his home.

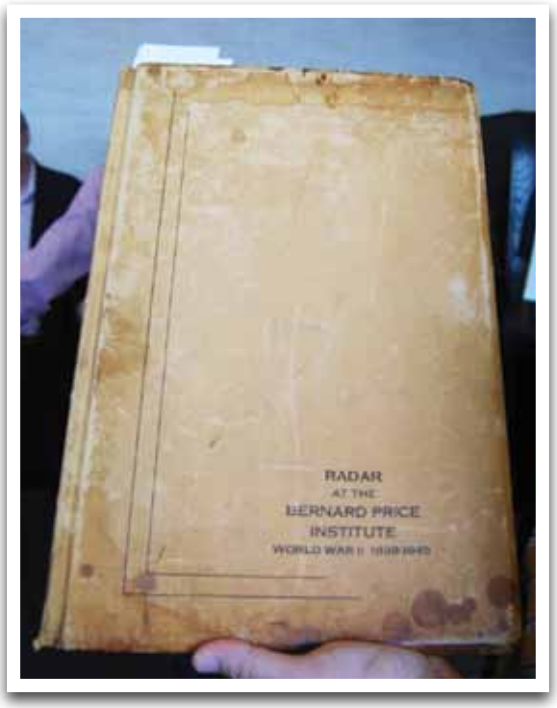
He served on the original SAIEE HIG committee (now the Historical Section) for a while and at some point in time handed the book over to the Vice-Chairman, Dirk Vermeulen, who kept it until an opportunity arrived when it could be placed in an appropriate library for safe-keeping.

The celebration to mark the 75th anniversary of the first successful radar transmission, the 16th December 2014 – covered in detail in the articles referred to above, was judged to be the correct time for returning the book to its "origina home", Wits University. The hand-over actually took place on Tuesday 2nd December, in the Senate House at Wits when various dignitaries were present including the Deputy Vice-Chancellor of Wits Prof Tawana Kupe, the Dean of the Department of Electrical Engineering Dr Ian Jandrell and other senior University staff, as well as SAIEE Deputy President André Hofmann and members of the SAIEE Historical Section.

The book is still in remarkably good condition but is in need of a certain amount of restoration work from a professional book repairer. This will be arranged by Wits and the fully restored book will soon be placed in its final resting place in the Electrical Engineering Faculty's archives.

Electronic copies will be made of the restored volume and these will be available for research and a number will be distributed to selected organisations including the SAIEE.

From left: Prof Ian Jandrell (Dean of the Department of Electrical Engineering), Professor Tawana Kupe (Deputy Vice-Chancellor: Advancement, HR and Transformation), Dirk Vermeulen (Vice Chairman Historical Section, SAIEE) and André Hoffmann (SAIEE Deputy President).



The Book

Booyco Electronics Unveils New Electronic Checklist System

Booyco Electronics has unveiled its new Electronic Checklist System, a complementary product to its Biometric Control System. "This particular combination of products will ensure that only licensed users with a valid red ticket can operate any specific vehicle or range of vehicles and then confirming the vehicle was checked before operating in a mine environment, for example," Anton Lourens, Managing Director of Booyco Electronics, says.

The new Electronic Checklist System from Booyco Electronics complements its Biometric Control System.

WATTSUP

Smartgrid Conference February 2016

Smart Grids are the next generation of electrical grids that incorporate and make use of information and communications technology (ICT) to dynamically manage the electrical grid in terms of balancing supply and demand in real time. In effect Smart Grids bring together three technology domains: power generation and transmission, telecommunications technology, and computer and information processing technology.

Smart Grids provide the ability for information to be gathered, such as behaviour of suppliers and consumers, and for this information to be used in an automatic fashion to improve the efficiency, reliability, sustainability and economics of generating and distributing electricity.

It is strongly believed that the deployment of a Smart Grid would be of significant benefit to South Africa and Sub Saharan Africa, particularly taking into account the current shortage of generating capacity that this region is experiencing, and as such the South African Institute of Electrical Engineers (SAIEE) is planning to hold a Smart Grid Conference in February 2016.

The objective of the Conference is to bring together experts, both locally and internationally, to discuss the benefits of deploying Smart Grids, the various technology options available, and the economic and business plan viability of deploying this technology in Sub Saharan Africa.

An organizing committee, under the chairmanship of George Debbo (Council Member and Vice Chairman of the Technology Knowledge & Leadership Committee) is being set up, and more details related to the Conference as well as a Call for Papers will be issued early in 2015.

3 Phase Current Measurement

ProSys of the UK have released a new series of 3Ø micro-flex Rogowski current probes. There are three current ranges, 10A/100A/1000A, with a frequency response of 20Hz to 10kHz (-2dB). Battery life is typically 1000 hours.

The probe aperture diameter is 50mm, there are however other models available up to 100mm. The three separate coax output cables are terminated with a safety BNC connector.

Battery life is typically 1000 hours.

Current Probes

The Universal Technic model SC 2000 which has a capability of measuring AC/DC current up to 2000A. Frequency range is from DC to 10kHz with a accuracy on DC ± 1% and AC accuracy at 50Hz of ±0.5%.

The model in the illustration has a 52mm jaw and a co-axel cable terminated with a BNC connector. Other jaw sizes and current ratings up to 7500A are available.

Both products avaiable from Denver Tehnical Products (Pty) Ltd

Fastest-growing 3D marketplace CGTrader.com Launches 3D Robot Challenge

The new generation of robots is nothing like the sandwich-maker-type of machines that we thought them to be 20 years ago. Modern robots can look and behave like humans, pushing the imagination boundaries to extreme lengths.

Here at CGTrader we think robots are cool and they'll be integral to our future, but everyone knows that creative projects like building a robot have to start from the basics - it starts with an idea. What will the robot look like? What functions and features will it have? Will it be a cute, functional, military, utilitarian or steampunk machine? The CG Robots Challenge is designed with 3D artists in mind who are interested in exploring new concepts and creating something fresh and mind-bending.

As artificial intelligence and robotics increasingly take the spotlight in near-future predictions, CGTrader.com launched the challenge to its community of over 120,000 3D designers in order to design and visualize the robots of the future.

The challenge encourages designers to explore the sci-fi theme with the most advanced technological creatures that could well be our neighbours, counterparts or even enemies in the coming decades. The challenge requires creating robot 3D models and uploading them to CGTrader.com. The participants will be competing for the Best 3D Robot model and Best 3D Robot portfolio – in the latter category, designers with more models are more likely to become the winners. Each category will have a winner and two runner-ups.

The challenge ends on the 15th February 2015. The designers will be competing to win Motion Design Bundles by Video Copilot, iClone Animation Pipeline Toolkits by Reallusion, two KeyShot5 licenses by Luxion, one CGschool video from V-Ray or 3ds Max by CG School, 200 credits and promotional features by CGTrader. The runner-ups will also be rewarded with prizes such as 3D Shader Bundles by Video Copilot, iClone5 PRO Bundles by Reallusion, Video of choice from V-Ray or 3ds Max classes by CG School and 100 credits by CGTrader.

"Over the past years robot models have become the fourth most popular category on CGTrader.com and we believe it is an amazing topic to capture the imagination of 3D designers who are fascinated by both machines and video games. We see the 3D Robot Challenge as a great opportunity to look into the future, improve your skills and use the holiday downtime to play and create for the futuristic theme." says Marius Kalytis, CEO of CGTrader.

CGTrader.com has been constantly encouraging 3D designers to participate in various challenges to foster creativity and imagination. Its challenges have helped designers discover new themes as well as win amazing prizes, and even produced several world-firsts.

Currently, CGTrader also runs 3D Systems Art Challenge, 3D Architecture Challenge and 3D Printed Kids' Toys Challenge, where designers can submit both paid and free 3D models.

Africa - the new frontier for nuclear power development

Africa is fast becoming the continent of choice for the development of nuclear power. Currently South Africa is leading the way in Africa with the Koeberg Nuclear Power Station having been established in 1984, comprising 2 nuclear reactors and generating 5% of South Africa's electricity.

In the 2011, Draft Integrated Electricity Resource Plan for South Africa – 2010 to 2030 (IRP), nuclear prospects were revived, for 9600 MW, supplying 23% of the country's electricity. In 2014, nuclear cooperation agreements with Russia, China, the USA, Korea and France have been signed. The South African Energy Minister said, *"This paves the way for establishing a nuclear procurement process."*

According to the World Nuclear Association, countries considering nuclear power programs include Ghana, Senegal, Namibia, Sudan, Uganda and Namibia, while countries already developing plans include Nigeria and Kenya.

In Kenya, the government is serious about installing a nuclear power plant and has already identified some potential construction sites; a facility could be operational within five years if all goes according to plan, and $3 million has already been allocated to an energy planning committee.

The World Bank says fewer than 10 percent of African households have access to electricity. That, in turn, hampers industry and development on the world's poorest continent. This dire need for power has pushed many African nations to consider nuclear energy as a possible solution to meet their energy demands.

The development of nuclear energy in Africa will be discussed at the upcoming Africa Energy Indaba with a stellar panel comprising industry experts, including:

- Des Muller, Director and General Manager, Group Five Nuclear Construction Services (Pty) Ltd
- Dr Yves Guenon, Managing Director, AREVA South Africa
- Dr Rob Adam, Group Executive, Aveng and Chairman, Nuclear Industry Association of South Africa (NIASA)
- Dr Dawid Serfontein, Senior Lecturer, School of Mechanical and Nuclear Engineering, North-West University
- Phumzile Tshelane, CEO, Nuclear Energy Corporation, South Africa (NECSA)
- Mr Viktor Polikarpov, Vice President, Rosatom Africa

The panel will focus on key issues relevant to the development of nuclear power including:

- The business opportunity around the development of nuclear power in Africa;
- The impact of nuclear power in African countries;
- Where to start and how to finance a nuclear power plant;
- Safety issues surrounding a nuclear power plant; and
- The benefits and growth potential for an African country by installing a nuclear power plant. wn

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PV Excellence: Get invaluable insight on how experienced PV companies are making dramatic cuts in costs in bids and learn how to compete in the <6 cents/kWh new scenario

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MP4 services shed light on electrical installations

Electrical distribution equipment powers practically every business on the planet. As such, it is the lifeblood of a business and is responsible for maximising production levels by increasing installation availability and quality, as well as improving a business' operational expenditure and optimising its capital expenditure.

Few businesses, however, have a clear understanding of how to maintain their equipment optimally or how to predict dangerous and costly faults, especially when electrical infrastructure is not the core focus of the business. Unfortunately though, this puts these businesses on the back foot in terms of competitiveness.

Furthermore, it opens up risk avenues in terms of cost, and threats to the building due to an increased possibility of electrical faults leading to safety risks for employees.

"To minimise these risks for organisations, Schneider Electric created 'MP4' services, which assess the performance of customers' electrical installations and propose improvements to meet their business energy needs," explains Roland Bartle, business development manager for the Mining, Minerals and Metals (MMM) industry in Southern Africa at Schneider Electric, a global specialist in energy management.

The MP4 methodology is based on four steps, producing four detailed plans per customer:

The maintenance plan aids in the development of a tailored maintenance schedule to both ensure the right type of maintenance is applied for each piece of equipment and to minimise equipment downtime. The plan also identifies which maintenance operations the customer can complete and which require a service specialist. *"A tailored maintenance plan also helps to keep maintenance costs optimal,"* says Bartle.

The modernisation plan indicates which equipment needs to be modernised, and when. It includes guidance for managing equipment end-of-service life and obsolescence (through replacement or retrofit) as well as suggestions for improving installation performance (by altering the electrical architecture).

The monitoring plan recommends a strategy to implement a monitoring system, taking into account the customer's specific requirements. It includes an assessment of existing monitoring capabilities and clear recommendations on where, how and why to improve monitoring.

Lastly, is the management plan, which focuses

on organisational aspects of operating and maintenance activities. It also reinforces the technical recommendations provided by the other three plans, providing economic control over the recommendations.

The management plan also addresses obsolete equipment and end-of-life steps, spare parts policy and procedures, operating conditions and maintenance contracts, organisation and training of technicians, and a follow-up of the action plan.

Since 2005, when MP4 services were first introduced by Schneider Electric, more than 400 customers, from industries as diverse as buildings, electric utilities, healthcare, industries, MMM, and oil and gas, have undergone MP4 assessments.

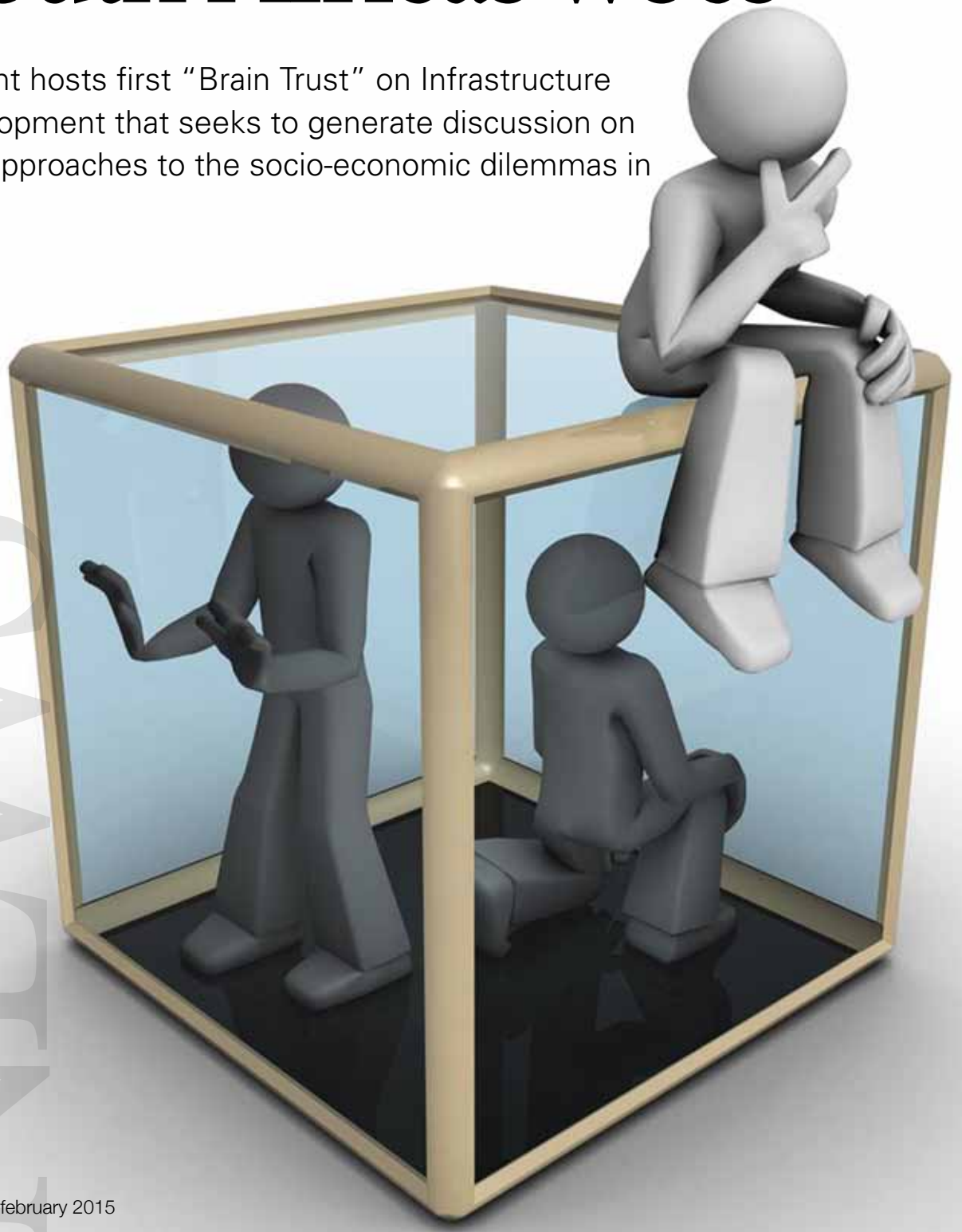
The organisation's MP4 services provide customers with a full assessment of their electrical installations, as well as a clear action plans. In addition, customers receive a list of critical safety issues to be addressed. Bartle highlights that the benefits of MP4 services include improved employee safety, enhanced quality and performance, greater reliability and peace of mind.

"*With MP4 services, our customers are provided with a detailed vision of the status of their electrical distribution installation, and four concise plans to help guide them in the future. This helps them to plan maintenance accordingly and avoid costly downtime,*" adds Bartle.

"*The value of this is clear, it's peace of mind and the freedom, allowing our customers to focus on their core business,*" he says. wn

Private sector thinks 'out of the box' on South Africa's woes

DuPont hosts first "Brain Trust" on Infrastructure Development that seeks to generate discussion on new approaches to the socio-economic dilemmas in Africa



The private sector should collaborate with government to solve South Africa's problems and brainstorm workable solutions that lend themselves to public-private partnerships. A more proactive approach, innovative thinking and the willingness to work together could achieve far more than the general tendency to point fingers and complain.

This was one of the main points made at the first "Brain Trust" on Infrastructure Development held in Johannesburg on 3 December, a private sector platform hosted by DuPont that seeks to generate discussion on new approaches to the socio-economic dilemmas of South Africa and the rest of the continent.

"Government keeps asking how the private sector can contribute and we always say government must make the environment conducive. Let's see how we can meet government halfway," said Macfarlane Moleli, facilitator of the discussion.

This first Brain Trust was a collaborative effort involving four private sector players concerned about the lack of productive engagement between government and the private sector.

The companies consist of global science company DuPont, law firm Hogan Lovells, investment company Shanduka Group, and REDISA (Recycling and Economic Development Initiative of South Africa). There are plans to introduce similar forums involving other private sector players from various industries in the future.

At the discussion, representatives of all four organisations emphasised the importance of pooling knowledge and sharing experience.

"Issues could be solved if we think innovatively and collaborate, because no company or organisation can solve Africa's challenges alone," said DuPont P&IP Business Leader, Richard Ntombela, referring not only to collaboration between the private sector and government, but also between business in South Africa and in other African countries. *"South Africa is well developed and has the resources and know-how, but how do we take our knowledge and share it with the rest of Africa"?*

Stacey Davidson of REDISA said one area where South Africa had been highly successful in public-private collaboration – and could share with other African countries - was the tyre recycling industry. *"This is an example of real out-of-the-box thinking. Instead of focusing on the linear economy where products are sold, distributed and thrown away, we should perhaps start focusing on stimulating the circular economy, where waste is turned into worth and not thrown away."*

Julian Nixon of Shanduka Group said another successful example of public-private partnership in South Africa was the ongoing renewable energy programme, REEP. *"We have seen government take the lead and it is a well-run programme. Through this public-private partnership, an international company has set up a wind tower factory in Cape Town and is making technology that previously was imported. Now we need to take our best practices further and show that when we engage with each other and with international companies, we address issues."*

Commenting on the relationship between business in South Africa and the rest of Africa, Rajen Ranchhoojee, head of the Africa Desk at Hogan Lovells, said South Africa was at a crossroad in a sense. *"South Africa needs to decide whether we want to be a springboard into Africa or an innovator. Do we want to be a country that grows through the benefit of foreign direct investment or do we as the most developed country in Africa want to capitalise on Africa by sharing and investing? South Africa is not nearly active enough in engaging the rest of Africa. It is only in the last five years that South African firms have really taken an interest."*

All four panel members agreed that it was essential to fill the vacuum between government and the private sector by discussing and collaborating on solutions that have already been shown to work and could be extended to other areas of the economy or the continent.

They also agreed that the Brain Trust should not become just another "talk shop" but a platform for putting words into action. wn

SA Businesses urged to invest in Customised Solar Solutions

"The rising cost of energy paired with the unreliability of the national electricity supplier has become a growing concern for SA businesses that are heavily dependent on electricity supply. In the light of this many business owners are starting to consider renewable sources of energy such as Photovoltaic (PV) solutions – better known as solar power –as a sustainable energy source, which is now accessible without risking upfront capital."

This is according to Manie de Waal, Head of Sales at Energy Partners, a leading energy solutions provider in South Africa, who says that a company can collaborate with a reputable solar partner that invests in its client's site at its own cost by installing and maintaining the PV solution.

"The solar power that is generated is then sold to the company at an agreed upon rate (below grid power rates) These Purchase Power Agreements (or commonly referred to as PPA's) minimises the financial and operational risk for the client as all the responsibility for system performance and maintenance falls on the energy partner. As part of the PPA the client has the option of purchasing the PV system at any time."

He warns however, that it is imperative to partner with a reputable supplier. *"The solar industry is new and booming and with that there are many operators that do not have the experience, capabilities or intent to deliver a long term and sustainable partnership to clients."*

The minimum expected electricity generated by PV panels 25 years after installation should be at least 80% of the original production capacity, says de Waal.

"In addition to this, a 5 to 10 year guarantee is typically offered on the electronics. It is also critical to ensure that the rest of the components used in the installation (cables, mounting structure etc.) are sourced from reputable suppliers, as these components will be exposed to the environment for decades to come."

Another aspect to keep in mind is that PV solutions in South Africa have not been standardised yet and should this come into play in future, taking shortcuts now can cost the company dearly in the long term, he says.

De Waal says that the first and most important step is to select the right PV solution for the specific site. He lists the following three basic solutions:

- Firstly there is the grid-tied PV solution without battery storage. This solution ties into the power grid and feeds the load with the solar power that is generated. While this solution is likely to decrease utility costs, it is not suitable for uninterrupted power supply (UPS) as the solar system is completely dependent on the grid to transport energy.

- Secondly there is a grid-tied solution with battery storage. This solution is also tied into the grid when it is available, but excess solar power can be stockpiled and utilised when required, for example in the event of a power outage.

- The last, an off-grid PV solution, has no connection to the grid and acts as the main source of electricity, often assisted by diesel generation in the event of prolonged periods without sunshine.

De Waal adds that while it is imperative to tailor the solution to meet site specific needs, for some sites the system can be implemented gradually. *"The most popular method is to initiate the process by implementing a grid-tied system without storage to avoid the initial cost of batteries. As more blocks are connected to the PV solution, a battery is added for UPS functionality or to even take the system off-grid completely."*

He says that PV solutions are especially suited for sites that are exposed to a lot of sunlight, have north facing non-asbestos roofs and that have a tariff structure with a large energy (kWh) component.

"Besides the immediate cost savings, PV solutions are also robust and requires little maintenance except for regular cleaning of the panels and a monitoring system to measure output. The energy savings of an effective PV solution can be hugely beneficial for local businesses in the long term due to the reduced cost of energy, not to mention the benefit of not being 100% reliant on the national energy supplier," concludes de Waal. wn

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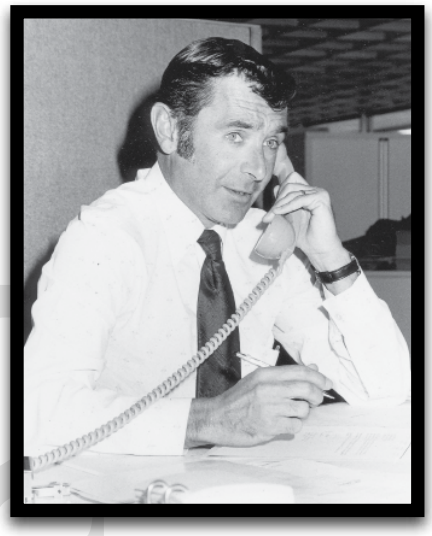

Peter John Horne

The following is a compilation of information and views from the colleagues, family and friends of Peter Horne. Our photo collection of Peter shows most often a gentle smile, or a big wide smile. Less often, particularly as a small child there was an intense frown. However it is the gentle smile that most people comment on and remember.

1939 - 2014

Peter Horne grew up in Durban North and was educated at Durban High School. Here his talents as sportsman led to success in distance running and after playing the bugle in the school band, to promotion to Drum Major. Peter graduated in Electrical Engineering from Howard College (later to become UKZN, Durban). After graduating, he was invited to join Metropolitan Vickers in the UK.

Peter returned to South Africa with his wife Doreen, whom he had met and married in England. For many years they were staunch supporters of St Chad's church in Edenvale, where Peter sang with the choir and became a lay preacher, while Doreen assisted with serving duties, and both participated in fund raising, bible studies and assisting less fortunate parishioners. Sadly, Doreen predeceased Peter by two years, after caring for him devotedly in his sad illness.

Peter joined First Electric on the East Rand, before moving to Escom in August 1967. At Escom he first worked in the Power Station Electrical Engineering Design section of the Head Office at Escom Centre ("King Kong's Throne") in Braamfontein, specialising in user specifications for acquisition, inspection and testing, installation, commissioning and maintenance of electric motors for power station auxiliary plant.

After an Escom reorganisation in the 1970s, Peter was entrusted with managing power station projects in the New Works department, coordinating the work of contractors and Escom specialists in all necessary disciplines to get the work completed on time, to specification, and within budget. His projects included completion of Grootvlei Unit 6, off site power back-up from the Acacia gas turbines for Koeberg nuclear power station, the Orange River Hendrik Verwoerd (now Gariep) hydro power units 3 and 4 and Van der Kloof 1 and 2, and Lethabo Power Station.

Peter was highly respected by Eskom senior management as a man of high esteem, dependable and very competent. His colleagues at many levels of the organisation remember Peter as a true engineer and gentleman, understanding and with an easy smile. It was better to have Peter on your side in an argument. He would consider arguments seriously, but having made up his mind, was not easy to convince that he might be wrong.

After Peter retired from Eskom, he was recruited by his previous Eskom boss to serve as project manager for the prestigious ABSA Bank building construction in down-town Johannesburg, which he saw through to a successful conclusion. He also assisted with development of pensioner payment logistics.

In the words of the then Eskom Executive Director, Technology, Peter and his colleagues greatly served South Africa, unstintingly applying their knowledge and expertise in building the core of our national electricity assets which earned Eskom international respect at the time, and continue to serve well, despite subsequent unfortunate interventions in the industry. And a tribute from another colleague: "What a magnificent legacy to Peter's life and work."

Peter and Doreen are survived by their daughter Lindsay, her husband Manie and their daughters, son David and his wife Trish, his sister Elizabeth, husband Dudley and family. Peter was a good man; loyal, faithful, very well named, and there was always a twinkle in his eye. Hamba Kahle Peter, and rest in peace. wn

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Mediatech 2015 on the horizon

The eighth biennial advanced media and entertainment technology tradeshow, Mediatech Africa, is set to kick off on 15 to 17 July 2015 at the Dome at Northgate, Johannesburg, South Africa.

Mediatech is Africa's premier trade show in this arena and many exhibitors in the live entertainment technology, AV systems integration, broadcast, film, production, post-production, animation and new media, studio and recording and pro DJ equipment sectors will have their wares on display. This creates an open platform to showcase new products and technologies and sets the stage for effective networking.

Mediatech Africa 2013 saw a total of 6935 visitors walk through the door over three days including 424 foreign visitors of which 197 were from the African continent. 136 companies exhibited in total, collectively representing just short of 700 brands.

Of these visitors, 37% were decision makers in their respective companies while 19% filled senior management positions. That being said, 49% of visitors had power of purchase while 30% had influence of purchase.

For more information visit www.mediatech.co.za

Empowering South Africa through technology

A large number of South African corporates are involved with an array of CSI and community based projects, and rightly so as those projects form part of a necessary and significant strategy to moving the country forward.

The social development and investment landscape, like many other landscapes, comes with its own set of challenges and opportunities. You might ask yourself what these challenges and opportunities are and the answer to that question is bandwidth and mobile data costs – a resource that is limited, in high demand, expensive, yet has high value.

At the heart of most well-managed CSI and community based projects there is usually a cornerstone that speaks to helping communities and individuals help themselves. Equipping and upskilling takes a great deal of time and resources if it is done correctly. However, this is where both the challenge and opportunity lies.

Recently, Flick met with a client that is currently doing incredible work to uplift communities. *"The challenge our client faces is that they take a long time to equip people in the community to equip others,"* says John Louis West Director of Flick. Additionally, the sheer volume of information and the method of presentation are intimidating elements to say the least. *"With this in mind, message consistency is a major challenge as well as understanding the message"*, says West.

As the Flick team continued working with its client, they realised the need to reinvent the content and the delivery thereof.

West says, *"Visual thinking in the form of short explainer videos and flow diagrams are essential in terms of getting a target audience to grasp the context of the content first instead of getting lost in all the detail."*

Now to up the ante, this content needs to be distributed on mobile phones, tables, etc. According to West, this will ensure easier assimilation of information and consistent messaging for all parties involved. It also means that the reach will be expanded into more remote parts of South Africa and Africa.

This is where we see pressure being put on bandwidth and mobile data costs in South Africa. At the moment cost and access to data is not favourable to the poorer communities that really need it. *"It's fantastic to see initiatives like free Wi-Fi at schools and certain towns transforming into Wi-Fi free zones. We also see new cables being laid and 100meg line speeds being offered and that is all a great sign that costs will ultimately come down. We just need to make sure that this also gets rolled out to the people that really need it and the reason for this is not to be charitable, but rather to empower our country through technology,"* ends West."

Yokogawa Wins Control Systems Order for Thai Binh Coal-fired Thermal Power Plant in Vietnam

Yokogawa's subsidiary, Yokogawa Engineering Asia, has received an order from Toshiba Plant Systems & Services Corporation to deliver control systems for the Thai Binh coal-fired thermal power plant in Vietnam. Toshiba Plant Systems & Services will be responsible for installing the electrical and other facilities at this power plant.

The Thai Binh coal-fired power plant is being built in the Thai Thuy district of Thai Binh province in northern Vietnam by Vietnam Electricity (EVN), a national power company. With two 300-MW units, the plant will have a total output of 600 MW. The first unit is scheduled to start operation in October 2017.

For the control of the boilers in each unit and the integrated control and monitoring of the boilers, turbines, and auxiliary facilities throughout the plant, Yokogawa will deliver the CENTUM® VP integrated production control system and

the ExaquantumTM plant information management system. Yokogawa Engineering Asia will be responsible for the engineering and delivery of these systems, and will provide support with installation, commissioning, and operator training. The delivery of all systems for unit 1 will be completed by September 2016.

Yokogawa has a long track record in delivering control systems to the power industry in Vietnam, and the company's systems are currently in use at facilities such as the Pha Lai 2, Vung Ang 1, Nghi Son 1, and Mong Duong 2 coal-fired thermal power plants. Yokogawa was able to win this order thanks to its strong project implementation capabilities and the high reliability and long-term stability of its products.

Throughout Southeast Asia, demand for energy is rapidly growing in line with economic growth. The Southeast Asia Energy Outlook–World Energy Outlook Special Report published by the International Energy Agency (IEA) in September 2013 predicts that Southeast Asia will need to invest 1.7 trillion dollars in energy infrastructure by 2035 and that the electric power industry will account for approximately 60% of this total. Currently, over 30 coal-fired power plants are either under construction or in the planning stage in Vietnam, making this country one of the region's most active investors in electric power.

Encouraged by its success in winning this order, Yokogawa plans by fiscal year 2017 to win 100 million dollars in orders in Southeast Asian and South Asian markets such as Vietnam.

Cbi Launches New Metal Switches And Sockets Range

The newly launched CBI-electric: low voltage Metal range of switches and socket outlets feature a metal white plate for durability. Switch inserts feature a fluorescent strip for ease of use and a modern look.

The aesthetically pleasing Metal range was developed due to demand from consumers. It features screw less cover plates and offers SA/European socket outlet combos. It is available in a number of switch and socket configurations as well as blank cover plates. Rated for 240V AC and with a current rating of 16 Amps the range is both SABS approved and SANS 164 compliant.

CBI-electric: low voltage, previously known as Circuit Breaker Industries or CBI, is located in Johannesburg, South Africa. CBI is a manufacturer and supplier of quality low voltage electrical distribution, protection and control equipment. CBI supplies products to multiple industry sectors including: Residential, Commercial, Industrial and Mining applications, as well as Utilities. Products include Miniature Circuit Breakers, Moulded Case Circuit Breakers, wiring accessories and specialised application Circuit Breakers. CBI-electric: low voltage has established itself as a supplier of world class products and solutions to niche markets globally.

Schneider Electric has been awarded the Africa Best Employer Brand 2014

Schneider Electric Africa has been awarded the Africa Best Employer Brand Award for 2014/ 2015 at the annual "Employer Branding Awards (EBA)" organized by the Employer Branding Institute; World HRD Congress & Stars of the Industry group & endorsed by the Asian Confederation of Business.

This year's Africa Best Employer Brand Awards ceremony was held on December 10th, 2014 in Mauritius, where Phindo Mohlala, Vice President of Human Resources-Africa and Caribbean received the award in the presence of 200 senior leaders from companies around the world, Schneider Electric received the award based on certain criteria including but not limited to the company's ability to attract and retain talent as well as offer the best work environment for its employees.

This prestigious award is one of the top international awards granted to companies that demonstrate excellence in providing an integrated work environment that caters to employees' aspirations and motivates them to translate success and desired targets into achievements and performance.

Africa Best Employer Brand Awards consists of a panel of judges of experts in employment and human resources from unbiased bodies who base their decisions after reviewing a number of criteria related to employment and work environment, such as: being exemplary in learning and development initiatives, communicating distinctiveness in employee hiring, training and retention practices, and continuous innovation.

The most important evaluation methodology is the company's ability to create a culture of contribution and innovation at work, consistent improvement in Human resources policy by measuring organizational health and incorporating values that help achieve the vision, the company's ability to give workers equal opportunities, and develop and nurture future leaders. In addition, a number of other standards are examined including providing exemplary learning and development initiatives, communicating distinctiveness in employee hiring, training and retention practices, and continuous innovation.

QV.HS.2015?

In an age when abbreviated text messages are the order of the day and spelling and language are often "confusing"..... and technology "mind blowing", the Historical Section of the SAIEE believes that it is not only relevant, but that it is also a vital cog in the machine that is "Electrical Engineering in South Africa".

BY I MAX CLARKE I FSAIEE
CHAIRMAN I HISTORICAL SECTION

It is a truism, not just an opportunistic talking point, that you need to know where you are and where you have come from, in order to chart the way forward.....

QV... Quo Vadis, as Latin Scholars will know, and Wikipedia will confirm for us lesser mortals, means *"Where are you going ?"*...

HISTORICAL SECTION (HS)

Born Historical Interest Group in 1978, came into being thanks to the enthusiasm for preservation, and the dedication of a handful of Institute members. It was re-named Historical Section in 2002 and is still going strong in 2015 !

SO WHAT'S IS THE PROGRAM FOR THE NEW YEAR?

Broadly speaking we aim to have a significant set of displays in place in the Innes House Museum before year-end, and a major step taken in re-locating the library in the "old" HS building.

In a little more detail, by the time this appears in print the next display cabinets should be in place in Innes House and the Committee Members will be placing selected artefacts for the displays. Work should also be well advanced with the setting up of the amateur radio station in the "radio room" and the first displays of radios and related equipment should be in place. These will expand and support the existing pilot displays of telephones, X-ray tubes and scientific instruments that are already in place.

To take the museum to the next level, orders should also have been placed for the third batch of cabinets which, once installed and dressed, will take the displays to about 90% of what is currently envisaged.

In addition, as many of our readers will know, the HS library is currently housed in a section of the original outbuildings located behind Innes House. Also, a large number of journals, magazines and other documents are located "upstairs" in the double-volume building originally built to house simulator equipment for driver research in the days when NITR was based on the Observatory site.

What is planned, and is at an advanced stage of development, is that the existing library will be moved into the lower floor of the "double-volume" building adjacent to the present location, to make this largely a "papers" building.

HS Section:
(From left) Mike Little (Secretary); Bruce Jackson; Richard Dismore; Arnot Hepburn; Jerry Kobyzsky; Max Clarke (Chairman)
Absent: Dirk Vermeulen (Vice Chairman); P. Heim; Duncan Baker; Andy Johnston; Jane Buisson-Street

The space currently occupied by the books will be re-developed into an artefacts area, the precise form of which is still to be determined.

The necessary modifications to the building are already under way and include the creation of a small room at the east end of the ground floor for use as a "workshop" area, with proper steps from the new SAIEE House to facilitate access, and some paving and improvements to the general area drainage.

The HS is staffed by volunteers who meet in "work groups" week by week. Obviously things like cabinets and shelving and "consumables" are supplied by appropriate suppliers and contractors, but individual members find their niche in the every-day work that is necessary to keep the activities on track, and they run with it in the overall plan of activities. Some find satisfaction in identifying and registering artefacts or books, planning displays, doing minor repairs and maintenance, etc... All are specialist tea and coffee drinkers... why not join us and have some fun in the process of preserving our electrical heritage!

Send an email to mppc@mweb.co.za if you are interested.

Earn CPD Credits

Hendrik van der Bijl

The nineteenth century was an age of heroic engineering. Engineers such as Brunel, Telford, Eiffel and Stephenson made contributions on a scale not seen since the Gothic cathedrals of the middle ages, or the monumental works of ancient Greece, Rome, Egypt, China and Babylon.

BY | DUDLEY BASSON

This was a time when an individual could fully grasp every aspect of an enterprise without recourse to specialist consultation. The nineteenth century also saw astonishing developments in science and mathematics. One of the last heroic engineers born in the nineteenth century was Nikola Tesla who made huge contributions to electrical engineering. South Africa has its own heroic engineer in Hendrik van der Bijl, who not only set his country on course for industrialization, but also facilitated electrical telecommunications worldwide in a period that spanned two world wars.

Before proceeding with van der Bijl, let us take a brief look at the origins of electrical engineering.

Luigi Galvani (1737-1798) graduated in medicine and philosophy. He is famous for the discovery of bioelectricity by finding that frogs' legs would twitch when the nerves were touched by an electric spark, or probes of two different metals. This gives us the English phrase "Galvanized into Action" as well as galvanometer and galvanizing, for the zinc coating of metal. Galvanizing is usually done by hot dipping rather than by electrolysis. When the eighteen year old Mary Shelley heard about Galvani's experiments with frogs' legs she came to the idea of writing her famous Gothic horror novel 'Frankenstein'.

Italian nobleman Alessandro Volta (1745-1827) was intrigued by Galvani's work and went on to discover that electricity was not intrinsic to frogs. A quote from Volta: "*You must be ready to give up even the most attractive ideas when experiment shows them to be wrong*".

He was the first scientist to make an ordered list of the electrochemical series. He produced his famous voltaic pile in 1800 giving the scientists of the world an easily assembled source of electric current. This consisted of stacked cells of copper and zinc discs separated by sheets of cardboard soaked in a salt water or sulphuric acid electrolyte. In 1881 the unit of electric potential was named the Volt in his honour, for his great contributions to electrical science.

Danish Professor Hans Christian Ørsted (1777-1851) discovered in 1820 that an electric current could deflect a magnetic compass. This was the first hint

Hendrik van der Bijl

continues from page 27

that electricity could be of engineering significance. Ørsted did much pioneering work to determine the relationship between electricity and magnetism. He discovered that a current carrying conductor was surrounded by a circular magnetic field. He also did much chemical research and was the first to refine pure aluminium. He was elected as a Foreign Member of the Royal Swedish Academy of Sciences.

André-Marie Ampère (1775-1836), intrigued by Ørsted's work, became one of the founders of the science of electrodynamics. He discovered that two parallel current carrying conductors would exert a force on each other.

He also discovered the solenoid. His father had the idea that his son should avoid formal schooling and rather educate himself directly from nature. This, with access to his father's library, worked well. André also took Latin lessons in order to read the works of Leonhard Euler and Daniel Bernoulli. He would later become professor of mathematics at the École Polytechnique.

He was elected as a Foreign Member of the Royal Society in 1827 and a Foreign Member of the Royal Swedish Academy of Sciences in 1828. The unit of electric current was named the Ampere (SI symbol A) in his honour in 1881. In electrical calculations the symbols 'i' and 'I' are used for current in accordance with Ampère's usage 'Intensité du courant'.

Many scientists and inventors had a go at producing rotary mechanical power from electricity. These would either directly produce rotary power or use a solenoid and crankshaft similar to a piston driven steam engine. Possibly the most famous example is Michael Faraday's motor consisting of a bowl of mercury with a magnet in the centre. When a current was passed through a wire dangling into the mercury it would spin continuously around the magnet. Faraday also produced a simple DC generator using a copper disc and a permanent magnet. These were merely demonstration models without any commercial value.

The development of electrical machines was severely hampered by the lack of an adequate power source. The cost of zinc consumed by voltaic piles made electrical power many times more expensive than any other power source available.

The Daniell cell invented in 1836 was a great improvement on the primary zinc cell. This used two electrolytes – copper sulphate and zinc sulphate. The lead-acid rechargeable battery invented by Gaston Plante in 1859 remains in use to this day. Many other battery types have subsequently been invented.

A few key events in the development of electrical power:

- In 1828 Hungarian physicist Jedlik invented the first commutated rotary electromechanical machine with electromagnets.
- French instrument maker Hippolyte Pixii built the first AC generating rotating apparatus in 1833 and the following year a pulsed DC generator.
- In 1833 Sturgeon built and demonstrated a commutated rotary machine in London.
- Russian engineer and inventor Jacobi built a 15 W motor in 1834 and in 1835 demonstrated a boat with passengers propelled by an electric motor.
- The first US patent for an electric motor was filed by blacksmith Davenport in 1838.
- Scottish engineer Davidson developed motors for a lathe and a locomotive.
- In 1882 a large two phase alternator was built by J. Gordon.
- Italian engineer Ferraris invented the first commutatorless induction motor using two phase windings in 1885.
- Ferranti, with the help of Lord Kelvin in 1887, developed an alternator and went on to design the Deptford Power Station. This was the first modern AC power station.
- In 1888 engineer and physicist Nikola Tesla presented a key paper to the AIEE describing three patented two-phase four-stator-pole motor types:
  One with a four-pole rotor forming a non-self-starting reluctance motor, another with a wound rotor forming a self starting induction motor and the third a synchronous motor with separately-excited DC supply to the rotor winding. Westinghouse acquired Tesla's patents and retained him to do further developmental work.
- In 1889 Russian engineer Dolivo-Dobrovolsky invented the first cage and wound rotor versions of the three-phase induction motor.
- In 1891 Tesla patented an alternator which operated at 15 kHz.

DEVELOPMENTS IN SOUTHERN AFRICA

South Africa's first electric telegraph system, between Cape Town and Simonstown, started in April 1860. The line was a single galvanised iron wire mounted on poles with porcelain insulators. The return circuit was through the earth.

In 1882 Kimberley became the first city in the Southern Hemisphere to have electric street lighting and in 1904 the first to have an electric tram service.

Dr Bernard Price (1877-1948) became the founding Chief Engineer and later General Manager of the Victoria Falls and Transvaal Power Company (VFP) in 1906 (Registered in Rhodesia). Supplying power from the Victoria Falls to the Rand, 1 100 km away, did not come to fruition as it was found more practical to generate power locally from coal. A small power station was built at the falls in 1938.

In 1894 Siemens & Halske were the first to obtain a concession to supply power to the Rand and formed the Rand Central Electric Works Ltd., with a plant capacity of 3,2 MW.

In 1897 a concession was obtained by the Simmer & Jack Mine to form the General Electric Power Company with a capacity of 2,5 MW at the Driehoek Power Station. The VFP took over the supply companies in 1907 and purchased the way-leaves for a transmission line and the right to establish a power station at Vereeniging.

The VFP, using large modern turbo-alternators, was able to supply power at lower cost than that of steam driven equipment. The Central Mining-Rand Mines Group agreed to purchase the whole of their power requirements of electrical energy and compressed air from VFP for a period of 12 years and to shut down all of their boiler plant. Many other mines also took their power from VFP.

The Rand Mines Power Supply Company Ltd. (RMPS) was registered in SA in 1910, the entire capital being provided by VFP.

By 1912 the VFP built power stations at Brakpan, Simmerpan, Rosherville and Vereeniging with a total output of 160 MW, and electrically driven compressed air at Robinson Central at 3,5 MW capacity. Other large sources of power (59,2 MW) were from plant at Randfontein Estates Gold Mines, East Rand Propriety Mine and Johannesburg Municipality.

The VFP and RMPS established a scheme for the distribution of compressed air on a scale larger than anywhere else on the globe. In all, some 70 km of piping were installed – much of it of 70 cm diameter. The compressed air plant power totalled 117 MW by 1948. Gold mines typically need about a quarter of their power requirement in the form of compressed air.

A traumatic event in South Africa's industrial history occurred in 1922. A sharp drop in the price of gold in 1921 resulted in a drop in mine workers wages. This led to the Rand Revolt.

The situation became dire when the strikers armed themselves. Prime Minister Smuts mobilised the army and declared martial law. The VFP power stations were cordoned off by the army and kept in operation by available staff. The revolt was crushed, but at a cost of over 200 lives.

A spectacular disaster occurred at the Vereeniging Power Station in December 1925. The shaft of a turbo-alternator set sheared, sending massive pieces of metal through the roof and end of the building. The two ton rotor flew two kilometres across the Vaal River and into the Free State. Fortunately there were no injuries. The shearing of a turbo-alternator shaft is very rare, but two large masses on a common shaft pose another unusual risk of failure. The two masses will have a natural torsional oscillation. If this matches a sub-synchronous resonance in a long transmission line, supplied by the alternator, and left unchecked, this can lead to shaft failure.

With the establishment of Escom by van der Bijl in 1923, the new Witbank (60 MW initially) Power Station was financed and owned by Escom but designed, built and operated by the VFP. The Witbank Power Station came on line in 1926. A similar arrangement was used with the Klip and Vaal Power Stations. The Klip (completed in 1940) had a total capacity of 424 MW, possibly the largest steam powered station in the world at the time, and the first Escom power station to have cooling towers.

In 1945 negotiations started for the takeover of the VFP and purchase of its assets by Escom.

The VFP was purchased by Escom on 1 July 1948 for £14,5 million. Dr Bernard Price and Dr Hendrik van der Bijl both died in that same year.

DR HENDRIK VAN DER BIJL (1887-1948)

Hendrik Johannes van der Bijl was born on 23 November 1887 in Pretoria to Pieter

Hendrik van der Bijl

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Gerhard van der Bijl and Hester Elizabeth (née Groenewald). His father was a successful produce merchant and property developer, and was on friendly terms with future Prime Ministers Louis Botha, Jan Smuts and Barry Hertzog. He attended the Staatsch Model School in Pretoria but had to leave when it was closed to be used as a prisoner-of-war camp. War correspondent Winston Churchill escaped from this camp a day before he was to be released. The family moved to Gordon's Bay and Hendrik completed his schooling in Franschhoek. He was interested in music and literature, and had a deep interest in philosophy, but it was the exactness and logic of science that gave him the most satisfaction.

After graduating with honours in physics, chemistry and mathematics at Victoria College in Stellenbosch, he furthered his studies in Germany, first in Halle and then in Leipzig. Within two years he had completed his thesis to prove that the electron carried the same charge in ionized liquids as in gases. Not having any previous knowledge of German did not seem to trouble him at all. In 1912, van der Bijl, with MA and PhD degrees, took up his duties of Assistant in Physics at the University of Dresden. On the suggestion of the famous Professor Hallwachs, pioneer of the photo-electric cell, he investigated the emission of electrons from metals under the influence of ultra-violet light, and invented a device for measuring electron emission. In April 1913 he published a paper titled "The Determination of the Initial Energies of Photoelectrically Liberated Electrons".

Later in 1913 he was invited by the Western Electric Company (a subsidiary of the American Telephone and Telegraph Company – ATT) to investigate the 'Audion' device invented by Lee de Forest. He commented:
"When I joined the Western Electric Company at that time I was shown an Audion and was told that it was capable of detecting radio waves and capable of amplifying feeble telephone currents, but it was not known how or why, and that it was to be my task to find out".

He was astonished to find that this was identical to the thermionic valve that he had invented in Germany.

In its simplest form, a thermionic valve consists of an anode and heated cathode contained within a vacuum tube. This is commonly called a diode or rectifier valve. The cathode can either be self heating or heated by a separate electric circuit. By inserting a grid between the cathode and anode, the tube becomes a triode which can be used as a gate or an amplifier. This became the fundamental component of amplifier circuits. A number of more elaborate thermionic valves were developed and were sold in their millions around the globe. Every radio and gramophone amplifier had a selection of dimly glowing valves in its innards. At this time a 'radiogram' was a fashionable item to be found in nearly every house.

In 1924, a Mullard 4 pin version of the valve was advertised in a journal which might bring a sentimental tear to the eye of engineers who are well past retirement age. This was a monthly periodical published for very young aspirant engineers – the Meccano Magazine. The writer of this article had a moment of international glory in the October 1953 issue of the magazine. Thermionic valves do not have a strictly linear amplified output and were therefore not suitable for full-wave sound amplification. This difficulty was overcome by using a push-pull method for amplifying the positive and negative parts of the wave separately, giving Hi-Fi sound amplification.

Thermionic valves would remain the primary active components of electronics for decades until the dawn of the transistor age. Can anyone remember working with transistors which were small black capsules with three protruding wires? Discrete transistors are still manufactured, but most now occur embedded in integrated circuits. The number of transistors contained in an integrated circuit has been steadily growing over the years and has now reached billions. Thermionic valves were extensively used as logic gates in early computers.

While in the US van der Bijl also developed a scrambler telephone, and a means of sending photographs by wire.

In 1920 van der Bijl was urgently summoned by Prime Minister Smuts to return to South Africa to become scientific advisor to the government. In 1922 he produced a master plan for establishing a public utility company for the supply of cheap, reliable, electrical power to the mines, burgeoning industries and towns, on a non-profit basis. Despite much scepticism from some politicians, he established ESCOM (Electricity Supply Commission) in 1923 in record time, and which was so successful that he was able to repay the huge government loan within ten years.

This was probably the greatest single boost to the growing industrialization of South Africa. Escom initially collaborated with the VFP (Victoria Falls and Transvaal

Power Company – established in 1906 by Dr Bernard Price) which it eventually purchased in 1948.

The country had vast coal reserves with which to fuel the power stations. There were also vast reserves of high grade iron ore. Van der Bijl's next step was to establish a steel-making industry. Cast iron was produced in a blast furnace as early as 1918 by Pretoria Iron Mines Ltd., established by Cornelius Delfos.

In 1911 the Union Steel Company (USCO) was established in Vereeniging with a 100 ton open hearth furnace. This was to process scrap steel salvaged from the South African Railways. The first ingot was cast in 1913. USCO's ability to supply billets for pipe manufacture brought Stewarts and Lloyds to Vereeniging, expanding the industrial might of what was to become the Vaal Triangle.

Prime Minister Smuts invited Gutehoffnungshütte of Oberhausen to investigate the feasibility of a large scale steelworks in Pretoria. Steel was required in huge quantity by the mines, industry, railways and building construction. The first steelworks – ISCOR (The South African Iron and Steel Industrial Corporation) was established by van der Bijl in Pretoria in 1928 with rolling mills and cranes supplied by Demag GmbH (Now SMS Demag). The extremely heavy steel gantries were supplied by Dorman Long of Middlesborough. A jib crane used by Dorman Long in the construction of the Sydney Harbour Bridge ended up at the ISCOR Pretoria works. Dorman Long's Tyne Bridge looks like a scaled down version of the Sydney Harbour Bridge. The gigantic DC rolling mill motors were an awesome sight. I can remember climbing up a ladder to seat new carbon brushes on the enormous commutator of the generator of an Ilgner set supplying the mill motors. The gigantic flywheel was an awesome sight to behold.

The blast furnaces for reducing the ore to pig iron required vast quantities of ore, coke and limestone. Coke ovens were installed for processing great quantities of coking coal. The ovens provided coke for the blast furnaces as well as vast quantities of coal gas for heating throughout the steelworks, in particular, the rolling mills soaking pits. The steelworks had its own back-up power station for producing AC & DC electric power, and compressed air for the blast furnaces as well as reticulation throughout the plant. The blast furnaces produced toxic blast furnace gas which was used for heating the hot blast stoves. These pre-heated (1,200^{o}C) the air supplied to the infernos within the furnaces. The hot blast from the bustle pipe was blown into the furnace through water cooled copper tuyeres. Carbon monoxide formed an integral part of the smelting process. The coke ovens produced great quantities of by-products – Tar, pitch, benzole, ammonia and naphthalene. The blast furnace slag, initially dumped, also became a by-product. It was quenched in water and sold as granulated slag for making blast furnace cement. Blast furnace cement was advantageous in mass-concrete construction as it produces less heat than Portland cement. Steel was at first produced in open hearth furnaces. The Bessemer Converter, for converting iron to steel, lit up the night sky over Pretoria, especially on overcast days. Electric arc and oxygen lance furnaces came later. The Pretoria Works concentrated on profile steel – structural steel, railway tracks, shaft guides for the gold mines, reinforcing rod, window sections, fencing posts and wire. The South African Railways standardized on 96 lbs/yard flat bottom rails for mainline tracks. The Pretoria works also had a gigantic forge press which was used for producing the huge rolls required by the mills. There was also a gigantic lathe for finishing the rolls.

By 1934 ISCOR was producing the cheapest steel in the world. Two other steelworks were established, at Vanderbijlpark and Newcastle. The Vanderbijlpark works producing primarily boiler plate and sheet steel. All three steelworks were greatly expanded in subsequent years. As with Escom, the railways and mines, the steelworks created large scale employment for unskilled and semi-skilled labour, and also produced high value products for export. Sadly, the Pretoria works went into decline towards the end of the century and was eventually shut down. The rolling mills and cranes were sold off to India. The surviving works are now owned by Arcelor Mittal.

A quotation from van der Bijl: *It is not the Government's function to do everything for its people, but that it is its duty to create conditions that will encourage enterprise, not the type of enterprise that results in the unfair enrichment of some at the expense of others, but enterprise that results in equitable distribution of all the benefits.*

In 1927 van der Bijl was elected as President of the SAIEE which had been founded in 1909.

In the 1940s he worked on providing 35 mm movie film with sound by photographically adding sound wave forms to the edge of

Hendrik van der Bijl

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the film. Subsequently, other systems have been developed for Dolby, stereo and digital sound as well as synchronizing information for sound externally recorded on CD.

Van der Bijl established the IDC (Industrial Development Corporation) in 1940 for the development of economic potential. Also in 1940 he became an external member of the United States Institute of Radio Engineers and became deputy chairman in 1944. In the same year he was elected as a Fellow of the Royal Society – one of his greatest honours.

With the start of World War Two, Prime Minister Smuts appointed van der Bijl as Director General of War Supplies. He had to mobilize the country's resources to produce weapons, munitions, armoured vehicles and precision instruments. The quantity of war supplies produced was astonishing: 5 million hand grenades, 2 million mortar bombs, 10 million pairs of shoes, 6 million pairs of leather boots and huge quantities of small arms ammunition which were manufactured by the South African Mint.

Stewarts and Lloyds employed many women in the manufacture of shells. Other industries were also expanded to make the country less dependent on imports of clothing and foodstuffs.

During WW2 much research was done on radar using thermionic valves for transmitting and receiving equipment. It soon became apparent that very short wavelength high power was required for several specialized military and non-military radar applications. Longer wavelength power was advantageous for marine radar applications as it permitted the detection of targets beyond the horizon. It could not however provide the accuracy and compactness required by aircraft. In January 1946 a broadside dipole array antenna was used with a 100 MHz signal to measure the distance to the Moon.

Short wavelength power was achieved by means of the cavity magnetron that have been developed by John Randall and Harry Boot of the University of Birmingham in 1940. This also has a central heated cathode and surrounding anode in a vacuum chamber, similar to a thermionic valve, but here the similarity ends. The vacuum chamber is subjected to a strong magnetic field which causes the electrons to move from the cathode to the anode in circular arcs. A critical switch-off magnetic field strength is achieved when the electrons move in circles and return to the cathode. The anode is provided with chambers and gaps looking much like the revolving cylinder of a cowboy's six-shooter. The gaps and chambers provide distributed capacitive and inductive circuits which can be resonated by the electrons.

High frequency high power microwaves are generated in the chambers and are led away by a waveguide. When referring to microwaves this does not imply the SI prefix 'micro' but simply means 'short', typically in the centimetre-decimetre range. The basics of a magnetron are easily described but the detailed design and working are horribly complex. Magnetrons are now used in their millions to power microwave oven cooking.

Printed circuit boards have a long history of innovation, going back as far as 1903, but it was only during WW2 that they were manufactured in great quantity, for use in the proximity fuses of anti-aircraft shells. At this time valves were mounted on an aluminium chassis and the components connected by soldered wires. After this the development of printed circuit boards and integrated circuits was phenomenal, and eventually taken over by computer aided design and manufacture (CAD-CAM).

On 21 June 1946 van der Bijl became a partner and the driving force in the establishment of SAFMARINE (South African Marine Corporation) and became the first chairman. The IDC would later acquire shareholding control.

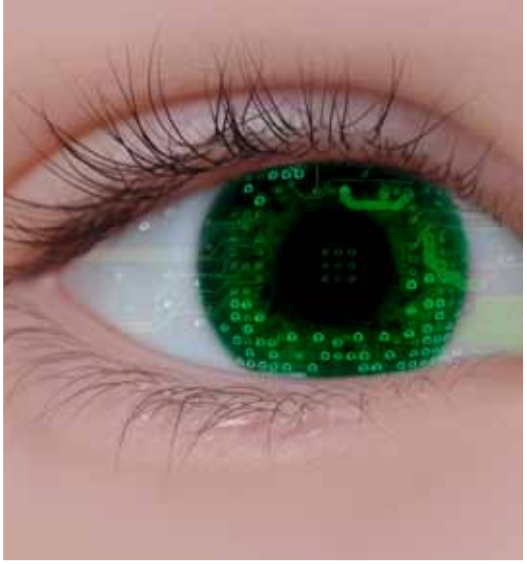
In 1947 he founded and became chairman of VECOR (Vanderbijlpark Engineering Corporation). In 1974 the DORBYL group was established from VECOR later to be changed to SARCO - South African Roll Company (Pty) Ltd.

In 1934 van der Bijl was appointed as Chancellor of the University of Pretoria – a position which he retained until the end of his life.

Dr Hendrik Johannes van der Bijl died aged 61 on 2 December 1948 in Johannesburg.

By the middle of the 20th century the electrical engineering world had reached a stage of comfortable stability. AC was the obvious choice for HV transmission lines as transformers could conveniently step the voltage up or down as required. Another advantage was that a balanced three phase line required no return conductor.

The single speed AC induction motor became ubiquitous due to the simplicity of design, low maintenance and low cost. DC power was the obvious choice for



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Hendrik van der Bijl

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traction motors and other applications where a wide range of operating speeds was important. DC was also advantageous in arc welding. DC was obtained from several designs of motor-generator sets or from AC rectification.

The mercury arc rectifier in operation was a splendid sight. A large glass vessel with limbs for the electrodes, a pool of mercury at the bottom and a large dome at the top where mercury vapour could condense and trickle back to the pool. These were in single and three phase versions. The fierce fiery arcs inside the vessel made it look like bottled lightning. These rectifiers were also available in metal containers. Selenium plate rectifiers developed in 1933 were also in common use until they were superseded by silicon diode rectifiers in 1970.

Thyristors, first commercially available in 1956, brought radical changes. These are four layer semiconductor devices with latching properties and can be shown schematically as two close-coupled transistors. Thyristors were at first regarded as laboratory curiosities without any practical application.

Thyristors come in a large variety of forms and can handle huge voltages and currents. They are widely used for rectification and inversion of power, and also variable speed drives for induction motors. They do however come with an inherent problem – clipping voltage waves can produce troublesome harmonics.

We now have a situation where it is possible to have HV DC power lines and undersea cables without the capacitive and inductive losses of AC. Variable speed drives have made AC motors the preferred motive power for trains and even the gigantic motors of ocean liners. Motor coaches for railway networks in the process of converting from DC to AC are made able to accept AC or DC power as required.

POWER STATION	ON LINE	SETS X MW	CAPACITY MW
Pretoria West	1952		180
Kelvin	1957	6 x 30; 7 x 60	600
Komati	1961	5 x 100; 4 x 125	1 000
Camden	1967	8 x 200	1 600
Grootvlei	1969	6 x 200	1 200
Hendrina	1970	10 x 200	2 000
Gariep (hydro)	1971	4 x 90	360
Arnot	1975	6 x 350	2 100
Kriel	1976	6 x 500	3 000
Acacia (gas)	1976	3 x 57	171
Duvha	1980	6 x 600	3 600
Matla	1983	6 x 600	3 600
Koeberg (nuclear)	1984	2 x 900	1 800
Lethabo	1985	6 x 618	3 708
Tutuka	1985	6 x 609	3 654
Kendal	1988	6 x 680	4 080
Matimba	1988	6 x 665	3 990
Majuba	1996	3 x 665; 3 x 716	4 110
Ankerlig (gas)	2007		1 338
Medupi	(2015-2017)	6 x 800	4 800
Kusile	(2016-2019)	6 x 800	4 800

Since van der Bijl's time, the electrical power infrastructure of South Africa has been considerably increased. Several ageing power stations have been decommissioned (see table 1). The Gariep Hydroelectric Power Station can perform a dual role – the alternators can be used as synchronous capacitors to correct adverse power factor and also stabilize erratic loads.

Free standing synchronous capacitors of 100 MVA rating are commercially available.

The construction of new coal fired power stations has come under considerable local and international criticism due to the huge CO_2 emission that they will produce.

Medupi, costing R170 billion, is expected to consume 14,6 million tons of coal per annum (1,700 tons/hour).

The largest power station on Earth is at China's Three Gorges Dam, spanning the Yangtze river, with an output of 22,5 GW. This power station has 32 main Francis sets, supplied by Alstom, running at 75 r.p.m. and each delivering 700 MW at 20 kV. The sets each have a vertical rotating mass of 5050 tons supported by self pumping water thrust bearings.

The alternators have a mass of 6000 tons each and an inner stator diameter of 18,5 m – this is engineering on an awesome scale. Power supplied to Guangdong is carried by a 940 km 500 kV DC power line.

Guangdong has a 2,4 GW pumped storage power station for load spreading. In addition to South Africa's coal fired power stations, a most interesting development was the creation of the Drakensberg Pumped Storage Scheme which, started in 1974, and came into operation in 1981.

This is a fully reversible hydroelectric power station driven by a huge head of water from the Sterkfontein/Driekloof dam and which is then stored in the low level Kilburn dam.

The power station has four Francis sets, each able to deliver 250 MW, running at 375 r.p.m. working with a 476,7 m head of water. The highly efficient, mathematically designed, Francis turbine bears no resemblance to the romantic 'Mill on the Floss' type of waterwheel. A Francis turbine can achieve an efficiency of up to 90%. Power is delivered during times of heavy demand and water is pumped back to the Driekloof (three gorges) dam when surplus electrical power is available. The power station actually consumes more energy than it delivers but it nevertheless provides an indispensable service for dealing with the highs and lows of power demand.

The system is designed for a daily cycle of 10 hours power supply to the grid and 9 hours of storage pumping. The system is also able to augment the flow of the Vaal river by diverting water from the Tugela river. Very little of the Pumped Storage Scheme is to be seen above ground – the huge turbine hall as well as the headrace and tailrace tunnels lie deep beneath the surface.

The Palmiet Pumped Storage System near Sir Lowrey's Pass in the Western Cape is able to deliver 400 MW.

The Ingula Pumped Storage Scheme is expected to come online in 2015. This is situated 23 km north-east of Van Reenen and 55 km from Ladysmith. The high level Bedford dam is situated in the OFS, and the low level Braamhoek dam in KwaZulu Natal, providing a 470 m head of water. The power station will operate four 333 MW Francis sets with an overall efficiency of 78%.

Some 275 bird species have been seen in the local wetlands arousing much interest by conservationists. New nesting sites have been prepared for birds inconvenienced by the filling of the upper dam. It has been proposed that decoy birds be deployed to entice the birds to make use of the new facilities. Another major addition to the power network is the Koeberg Nuclear Power Station of which construction was started in 1976. The two turbo alternator sets of 900 MW output each, came online in 1984 and 1985. Koeberg is situated on the Western Cape Coast not far from Melkbosstrand. Sadly, Koeberg has met with opposition and even sabotage from misinformed opponents of nuclear power generation.

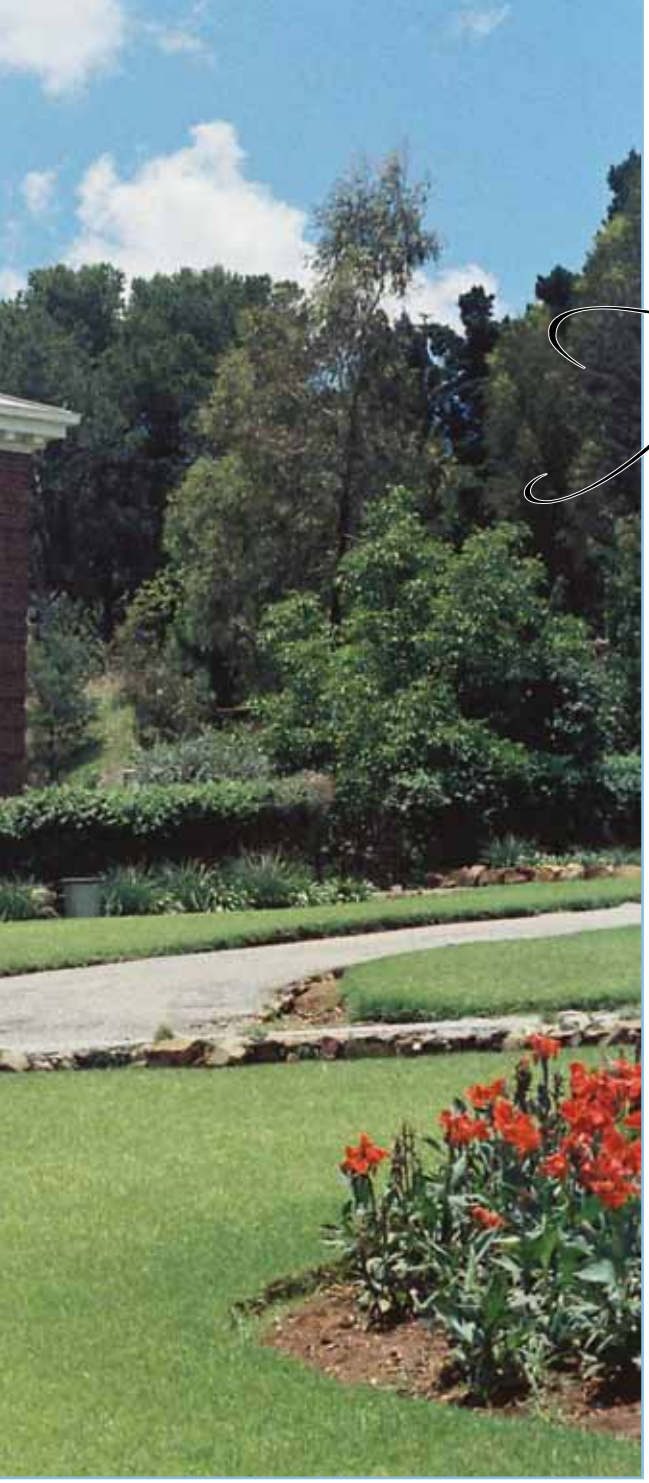
Recently, considerable capacity has been added by photovoltaic farms and also wind turbines. This is of course fair weather power, relying on friendly winds and sunny skies. Large scale photovoltaic power generation has been made possible by advances in photoelectric efficiency and the research continues to improve the efficiency even further. Full direct sunlight can deliver more than a kW of power per square metre. The availability of pumped power storage will greatly facilitate the use of wind and solar power.

South Africa's electrical power supply has by no means reached a point of stability – huge challenges requiring visionary leadership lie ahead. WN

Living amongst the Satellites

BY I RICHARD DISMORE I MA(CANTAB)
MEMBER HISTORICAL SECTION COMMITTEE

Gregory (Greg) Roberts was the last astronomer employed by the then Republic Observatory, and the last to live at 18a Gill Street, now called Innes House with his wife Maureen and their children, during the period 1970 to 1973.



Innes House as it looked during Greg's period of occupation

Although not licensed until later, during his period of tenure he was a radio amateur in the true sense and spirit as he used to track artificial earth satellites by means of their radio transmissions. Two of the rooms in the mansion, the lower and upper North-East rooms, were full of Greg's radio equipment.

Pictured in Fig 1 is the first equipment he used for weather satellite reception, the receiver and antenna system were constructed by Greg himself. The satellite signal modulated the z-axis of an oscilloscope and the decay of a charged capacitor provided the vertical ramp, with the horizontal sweep triggered by a circuit that detected the sync pulse in the satellite signal. The oscilloscope screen was photographed with a time exposure polaroid camera. Later, this system was replaced by a homemade facsimile system which served for many years.

The steerable antenna array was situated on the roof of what was the main observatory offices and consisted of 4 circularly polarized, stacked and phased crossed Yagi antennas for 136-138 Mhz. The whole system was controlled by antenna rotators and could be moved in azimuth and elevation. It's main use was to track the weather satellites of that period, and was a South African "first" closely followed by an installation at the SA Weather Bureau.

Greg knew from an early age that astronomy was his calling. He was born in Dundee, Northern Natal, on 29th October 1939 and was brought up with two younger brothers in nearby Glencoe. He attended school in Glencoe where he matriculated. He became an amateur astronomer at the age of 8 as a result of his mother's interest in astronomy and constructed his first 6-inch telescope when he was 13 years old, going on to construct about a dozen or so during his active life.

He obtained his degree in Physics and Chemistry at the University of Natal, Durban, where he experimented with amateur rockets and tracking satellites. This disrupted his academic progress for a while until his studies eventually took precedence!

Greg started his working career at Lever Brothers in Durban as an analytical chemist where he remained for several years. Never straying far from his first interest when in 1962 he formed Durban Satellite Tracking Station as well as a MOONWATCH station in conjunction with another radio amateur Arthur Arnold ZS5SU, who also introduced him to his future wife Maureen.

Living amongst the Satellites

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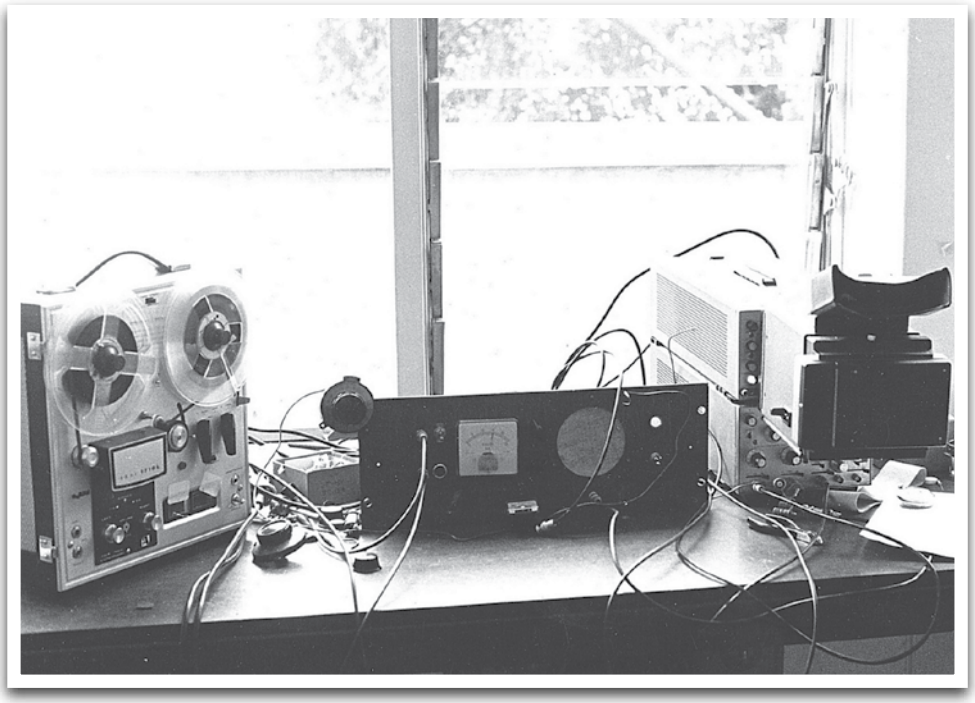

Figure 1 - RO set up

Moonwatch was initiated by the Smithsonian Astrophysical Observatory in 1956 to become the largest global scientific undertaking in history, to enlist the aid of amateur astronomers to assist professional scientists spot the first artificial satellites, which continues to the present day.

After a brief period as a chemist at Non-Ferrous Metals, he became Assistant Chief Chemist at the Mobil Oil Refinery at Wentworth outside Durban.

After about a year in 1966, Mobil offered him a transfer to their Technical Services Laboratory in Epping, Cape Town. He then married Maureen and the couple enjoyed a paid honeymoon cruise from Durban to Cape Town on the SA ORANJE. He stayed in Cape Town for about one year and worked part-time on the satellite tracking kinetheodolite at the then Royal Observatory.

His opportunity to live on hallowed ground came when a friend chanced to send him a newspaper cutting advertising a position as astronomer at the Republic Observatory to carry out a 5 year Planetary Observing Program for the Lowell Observatory under contract to NASA. He applied and got the position and moved to Johannesburg occupying Innes House as his residence and he managed the program for about 4 years until it closed when Innes House was turned into offices. He did a lot of satellite tracking in his spare time and observed two Apollo missions, 11 & 12 following the spacecraft out to about 200 000 miles on their way to the moon, using the observatory's 20-inch reflector telescope (since moved to Sutherland) and the 26,5 inch Innes refractor telescope.

Whilst at Innes House he obtained his experimental receiving licence giving him permission to possess receiving equipment for the satellite bands 136 to 2 300 MHz. Greg developed techniques for automatic picture transmissions from space vehicles using such satellites as ESSA 6 and ESSA 8 and the early NOAA and ITOS series. He became a licensed a radio amateur in 1974 shortly after leaving Johannesburg and arriving in Cape Town once again. He was first licenced with call sign ZR1BB (restricted then to 144MHz and above) and then with call sign ZS1BI, a full licence for HF and VHF. His experimental and amateur licences are still current.

He became very active in Amateur radio serving on the Cape Town branch committee and then the SARL itself as Technical manager. He founded SA-AMSAT, an affiliate to the Radio Amateur Satellite Corporation AMSAT of the USA, and brought South Africa in as a participant in the OSCAR (Orbital Satellite Carrying Amateur Radio) series of satellites. This earned him the Jack Twine Award for Merit as well as Radio Amateur of the Year from the South African Radio League (SARL).

Greg worked at the S.A. Astronomical Observatory in Cape Town from 1974 to 1999 in the Astrometric Department, playing a role in the GIOTTO spacecraft flyby of Halley's comet, the Comet Shoemaker-Levy that impacted on Jupiter, and the super nova in 1987. Finishing his career in the Photometric department, Greg "retired" at age 60.

Now at 75 years old he is still sleuthing satellites and writing regularly about the process in the bi-monthly proceedings of the Astronomical Society of Southern Africa. His recent historical articles were about the French Tracking Station at Paardefontein, the Baker-Nunn tracking

camera at Olifantsfontein, the "secret" American tracking station near Babsfontein, and he is working on a series covering the history of South African MOONWATCH teams and optical satellite tracking from 1957 to 2014.

He still holds an Experimenters License and is still active tracking certain satellites mainly on L and S-band using several dishes in the backyard of his home. On clear nights he also observes using video and CCD cameras and pioneered their amateur use in the tracking of distant satellites. He has a love-hate relationship with the US military as Greg and his small world-wide amateur network of at most a dozen observers currently generate and maintain orbital data on about 400 satellites not available elsewhere in the public domain, and make the data freely available on the Internet for others to observe them. Truly his is a "lifetime among the satellites". wn

Footnotes:
The period of Greg Robert's tenure at Innes house is recorded on pages 89 to 91 of Dirk Vermuelen's excellent book entitled "Living Amongst the Stars" Copies of the second edition are still available from the SAIEE priced at R250 each.

The HS section is establishing an amateur radio station in the Innes house museum with the callsign ZS6IEE under the custodianship of Richard, the author of this article to reflect the heritage of Toby Innes and Greg Roberts, radio amateurs who lived in and operated at this historic location, and to network with other museums. SAIEE members, who have a special interest in Radio or who are licensed radio amateurs, email Richard on erigid@gmail.com in order to receive a periodic bulletin of activities.

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Our Electrical Instrument Heritage

Electricity cannot be seen or touched and only small amounts can be stored. Lightning and the electric arc come close to a visual manifestation but what is seen in the visible spectrum is the energetic breakdown of the atmospheric gases into a plasma which emits a broad band of electromagnetic radiation from radio frequencies to ultra-violet light.

BY I RICHARD DISMORE I MA(CANTAB)
MEMBER HISTORICAL SECTION COMMITTEE

Often the analogy of water is used to explain the fundamentals of electricity, because water is tangible to the senses, can be seen, and pressure and flow felt but the analogy breaks down the moment you introduce magnetism, especially permanent magnetism for which there is no analogy.

The voltaic pile was the first electrical battery that could continuously provide an electrical current to a circuit. It was invented by the Italian Alessandro Giuseppe Antonio Anastasio Volta, a professor of experimental physics at the University of Pavia who published his experiments in 1800. It opened the door to a rapid series of discoveries in the fields of electricity, magnetism and fundamental chemistry.

The first detection of a relationship between electricity and magnetism took place on 21 April 1820, when during a lecture, Professor Hans Christian Ørsted of the University of Copenhagen, noticed a compass needle deflected from magnetic north when an electric current from a battery was switched on and off.

After a few months of intensive investigations he published findings, showing that an electric current produces a circular magnetic field as it flows through a wire. This discovery was not due to mere chance, since Ørsted had been looking for a relation between electricity and magnetism with increasing conviction since 1803 when he met a German Physicist Johann Wilhelm Ritter, who believed there was a connection between

Our Electrical Instrument Heritage

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electricity and magnetism. Ørsted's findings stirred much research into electrodynamics throughout the scientific community, influencing French physicist André-Marie Ampère's work on the magnetic forces between current-carrying conductors.

Ampère commenced work in September 1820 at the French Academy of Sciences on a mathematical and physical theory to understand the relationship between electricity and magnetism. Ampère showed that two parallel wires carrying electric currents attract or repel each other, depending on whether the currents flow in the same or opposite directions, respectively thus laying the foundation of electrodynamics. His most important discovery was the principle that came to be called Ampère's law, which states that the mutual action of two lengths of current-carrying wire is proportional to their lengths and to the intensities of their currents.

Portable multi-range laboratory Ohmmeter in wooden case with carrying handle believed to have been used in 1900. It measured resistance up to 1250 ohms. The manufacturer is unknown.

In 1827, Ampère published Mémoire sur la théorie mathématique des phénomènes électrodynamiques uniquement déduite de l'experience (Memoir on the Mathematical Theory of Electrodynamic Phenomena, soley deduced from Experiment), the work that coined the name electrodynamics. In the same year Georg Simon Ohm, a German Physicist and mathematician published his book Die galvanische Kette, mathematisch bearbeitet (The Galvanic Circuit Investigated Mathematically) in which he stated his law for electromotive force acting between the extremities of any part of a circuit is the product of the strength of the current, and the resistance of that part of the circuit. Now known as Ohm's law, it marked the early beginning of the subject of circuit theory.

The operating principle of electromagnetic generators was discovered in the years of 1831 to 1832 by Michael Faraday. His principle, called Faraday's law, is that an electromotive force is generated in an electrical conductor which encircles a varying magnetic flux.

Heinrich Friedrich Emil Lenz was a Russian physicist of Baltic German origin. He is most noted for documenting in 1833 how electromagnetic circuits obey Newton's third law and the conservation of energy. Lenz's law says: An induced electromotive force (emf) always gives rise to a current whose magnetic field opposes the original change in magnetic flux. The symbol *L*, conventionally representing inductance, is chosen in his recognition and the unit of the Henry is an anglicised version of his first name.

All the electrical cats were out of the bag now and from this time on the pace of development of electrical machines and power systems gathered momentum. By the second half of the century, mankind was receptive to practical applications. Discoveries were followed by inventions and patents. The lamp, the dynamo, the motor, the transformer, the meter and the turbine were invented in quick succession. This created the need to measure electrical parameters. Then, the only way to infer their otherwise invisible magnitude, direction, or polarity was to create an analog, namely the movement of a pointer over a visible scale. The early experimenters measured

A Universal Galvanometer made by Siemens and Halske, Germany in 1897. Siemens and Halske supplied this instrument to the Rand Central Electric Works (RCEW) after the construction of Brakpan Power Station in 1897.

currents with the tangent galvanometer where the restoring force which returned the pointer to the zero position was provided by the Earth's magnetic field. This made these instruments usable only when aligned with the Earth's field. Sensitivity of the instrument was increased by using additional turns of wire to multiply the effect but they were only capable of low power laboratory measurements.

Early voltage measurements exploited electrostatic repulsion or attraction, but the weak forces developed limited measurement to voltages above a kilovolt.

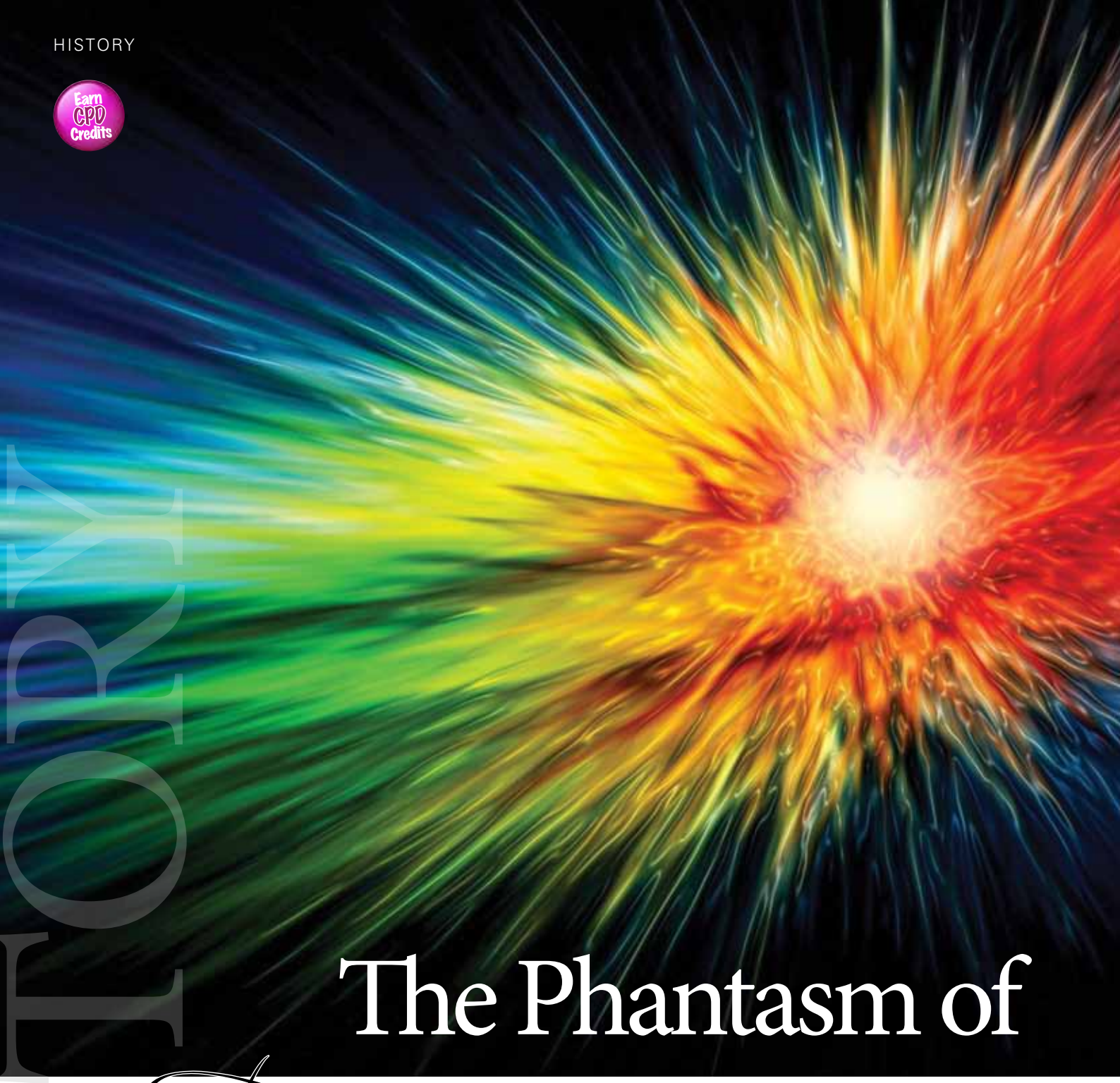
Voltage, current and power levels required to be measured increased rapidly and inventors achieved early success with moving iron instruments which were robust but were non-linear with cramped scales, and absorbed considerable power from the circuit under test.

The accuracy of measurement of resistance was greatly improved by the development of the Wheatstone Bridge which is an electrical circuit used to measure an unknown electrical resistance by balancing two legs of a bridge circuit, one leg of which includes the unknown component. It was invented by Samuel Hunter Christie in 1833 and improved and popularized by Sir Charles Wheatstone in 1843.

The book "Electrical Engineering Measuring Instruments" by GD Aspinall-Parr published in 1903 records *"The moving needle type comprises all instruments in which a piece of soft iron, free to move, is sucked or attracted from a weaker to a stronger part of a field due to a main solenoid suitably wound".* The vested interest of the big manufacturers is evident here, because 19 years earlier the largely unrecognised Jacques-Arsène d'Arsonval who was a French physician, physicist, pioneer in electrotherapy with high frequency currents, invented the D'Arsonval moving-coil galvanometer and the thermocouple ammeter in the nineteenth century.

The invention of the former in 1882 came after he had studied muscle contractions in frogs using feeble currents from a telephone. His design became the basis for almost all panel-type pointer meters in use until the present day. His thermocouple ammeter predated the discovery of radio by 4 years but became a mainstay of high frequency current measurement for 80 years.

With ever increasing power levels, measurement range of instruments was extended with Shunts, current transformers, voltage transformers and accessories to provide increasing safe isolation for the operator. Apart from measurements of frequency, timing, and pulse parameters which are inherently digital, in the heart of all digital meters are A to D (analog to digital) converters, the measurement of the electricity which we cannot see or touch is still sensed by analog devices. wn



The Phantasm of

Electromagnetic radiation spans a huge range of wavelengths, from more than a kilometre for longwave AM radio, to gamma rays with wavelengths less than picometres. It is only a tiny part of this spectrum which is discernable to human vision and is perceived as a range of colours from red to violet. Many other creatures also have colour vision, some able to perceive into the ultraviolet and others, the infrared. Honeybees, with ultraviolet vision are able to see patterns and colours in flowers invisible to humans. The mantis shrimp (Stomatopods) can see UV in six different colours as well as detecting polarized light. These creatures have one of the most complex visual systems of any creature yet discovered. Animals, such as the pit viper, are able to use infrared to locate warm blooded prey in total darkness.

Sir Isaac Newton (1642-1727) did much experimenting with glass prisms showing that white light could be split into colours and when recombined would again appear

BY | DUDLEY BASSON

Colour

There can hardly be any physiological faculty of human life more fascinating than colour vision. The human eye can discern up to a million different hues. Despite our constant awareness of colour throughout our waking hours, colour has no existence except in the consciousness of living creatures.

white. He also discovered 'Newton Rings', the coloured fringes produced when nearly flat sheets of glass are brought together or when a thin film of oil floats on water. Newton chose to sidestep the fringe issue with:

"I forbore to treat of the colours, because they seemed of a more difficult consideration, and were not necessary for establishing the properties of light there discoursed of."

If Newton did not forbear to treat of the colours he could have discovered the wave nature of light, Frauenhofer lines, interferometry and the huge science of spectroscopy.

In a letter to Harry Oldenburg, Newton wrote:
"… to determine by what modes or actions light produceth in our minds the phantasm of colour is not so easie."

A quotation on colour from Sir Arthur Stanley Eddington (1882-1944)

A rainbow described in the symbolism of physics is a band of ethereal vibrations arranged in systemic order to wavelengths from about 0,00004 centimetres to 0,000072 centimetres. From one point of view we are paltering with the truth whenever we admire the gorgeous bow of colour, and should strive to reduce our minds to such a state that

The Phantasm of Colour

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we receive the same impression from the rainbow as from a table of wavelengths. But although that is how the rainbow impresses itself on an impersonal spectroscope, we are not giving the whole truth and significance of experience if we suppress the factors wherein we ourselves differ from the spectroscope. We cannot say that the rainbow, as part of the world, was meant to convey the vivid effects of colour; but we can say that the human mind, as part of the world, was meant to perceive it that way.

German writer, poet and philosopher Johann Wolfgang von Goethe (1749-1832), in addition to his literary work, also took a keen interest in scientific matters, including botany and mineralogy. He accumulated the largest collection of minerals in Europe (17 800 rock samples) and wrote extensively on colour. More than 10 000 letters and nearly 3 000 drawings are extant. Goethe's most famous work is his play Faust which is a significant work in German literature. Astonishingly, he considered his "Theory of Colours" (Zur Farbenlehre) as a most important work.

He wrote extensively on primary and complimentary colours and colour combinations as well as the emotional impact of colours, but this was the work of a poet, not a scientist. He rejected Newton's view that black was simply an absence of light and claimed that black was also a colour. Beethoven was interested and wrote in his 1820 conversation book: *"Can you lend me the 'Theory of Colours' for a few weeks? It is an important work. His last things are insipid".*

Nikola Tesla was heavily influenced by Goethe's poem Faust, his favourite poem, and had memorized the entire text. It was while reciting a verse from Faust that Tesla came to the idea of the rotating magnetic field. The idea of the AC squirrel cage induction motor came to Tesla while walking in a park in Budapest and observing the sunset. Goethe's Faust became the subject of Gounod's famous opera, and many of Schubert's songs had lyrics by Goethe. In Faust, Mephistopheles is not portrayed as a red devil with green eye shadow and replete with horns and tail, but appears as a well dressed gentleman.

There is a curious anomaly in the association of light colour to heat, between common perceptions and physics. Blue is commonly associated with cold and ice and red with fire and heated metal. This is however quite unscientific. Blue light has a higher frequency and photon energy than red and has consequently the higher colour temperature.

James Clerk Maxwell (1831-1879) did much pioneering work on colour theory and also produced the first colour photograph. He chose the colours Red, Green and Blue (RGB) as the primary colours for additive mixing. This has become a de facto standard for additive primary colours. Other colours could have been chosen as primary provided that they are well spaced and that none of the colours can be produced by a combination of the other two. Colour triangles, circles and chromaticity diagrams are used to show the relationships and properties of colour.

Saturated primary colours contain no addition of the other two colours. By adding white the colours become desaturated – a fully desaturated colour will result in white. When mixing primaries additively they become lighter as adding components of the two other colours to a primary implies the addition of white. TV screens and computer monitors start with a black screen to which the images are added by means of RGB additive colours.

When additively mixing two primaries at a time, three secondary colours are obtained:

Red + Blue = Magenta;
Red + Green = Yellow;
Green + Blue = Cyan.

Subtractive colour occurs in the mixing of paints. The usual primary colours chosen are Yellow, Magenta and Cyan. Mixing the three primaries in the correct proportion will result in black. When mixing a primary with the other colours it will become darker. It is not possible to obtain white by mixing subtractive primaries.

When subtractively mixing two primaries at a time, three secondary colours are obtained:

Yellow + Cyan = Green;
Yellow + Magenta = Red;
Magenta + Cyan = Blue.

In ink-jet printing and watercolour painting, white is obtained from the background paper or other material. The ink or watercolour paint is translucent and filters white light twice as it passes through the colour and is reflected. Artists do not use the three primary colours for painting – many colours are not obtainable from subtractive mixing of opaque oil colours so that artist's colours are supplied in a huge variety of hues. It is no longer necessary for industrial paint outlets to stock a large variety of coloured paints. Computer controlled paint mixing machines can produce any of thousands of colours by dispensing pigments to white base material.

These machines use twelve or sixteen pigments to produce the colours.

Automotive colour matching and spray painting remains a highly specialized and complex task. The material consists of resin, tints, solvent and possibly metallic content. The final appearance can depend on the viscosity, speed in application and the underlying material. The hue can even be affected when spraying on plastic which may have acquired an electrostatic charge. A spectrophotometer can be used to determine the mixture of tints required to match existing paintwork. Paint bath dipping and robotic spray painting are very effective in obtaining a uniform finish but this is not practicable for repair work.

Subtractively mixing paints remains a skilled craft. There are also physiological issues with the perception of colour. Colours may sometimes appear to change hue when seen in proximity to other colours and a change of hue can also seem to occur when a colour becomes lighter. Colours can be severely distorted when seen in some sources of artificial light and completely lost in light from sodium vapour lamps. Colour is also less perceptible in weak light. Artists are well aware of these phenomena of perception. In van Gogh's self portrait with bandaged ear and wearing a green jacket (version with tobacco pipe), he provided two broad bands of colour for the background to contrast the foreground, despite the fact that his lodgings where the painting was done had white walls. The painting shows the right ear bandaged instead of the left as the artist painted the portrait using a mirror.

The essential components of the human eye are quite similar to those of a camera

Van Gogh's Self Portrait

– a lens for focusing and a retina as the detection instrument. The modern digital camera is actually a closer analogy than a film camera as this utilized a chemical process. The retina is composed of rods and cones. The rods are able to detect light of all visible wavelengths with more sensitivity than the cones so that colours are not perceptible in very dim light. In bright daylight viewing most of the visual information comes from the cones. The cones are of three types, sensitive to three different ranges of wavelengths but with some overlap – the one range has a peak in the red wavelengths and the other two have quite closely spaced peaks in the blue-green range. The pixel resolution of the retina matches the resolution obtainable by the diameter of the iris. The part of the retina with the highest resolution is the macula which contains the part used for the focus of attention.

The size of the focus of attention is surprisingly small – stare briefly at a single word on a printed page. This will be the only thing that is clearly visible – the rest is wide angle peripheral vision which is sensitive to movement and able to alert the owner of the eye to approaching company, prey or threats.

Direct light from the Sun reflected from snow is regarded as a good source of white. Sunlight has a fairly even energy level over the visible spectrum but tapers off in the infrared and ultraviolet. Radiant power from the Sun on a square metre is variable, but contains about 582W infrared, 481W visible and 56W ultraviolet. When observing white light, it does not make any difference if the light consists of a continuous spectrum of frequencies or three narrow bands of primary colours. The retina cones will in either case gather the signal as three streams for further processing.

Lithographic printing originated in 1796 using limestone plates, and has subsequently developed into a huge worldwide industry capable of high speed printing of text and colour images. Many of the old limestone plates remain of historical importance.

Lithographic plates have smooth surfaces and rely on the natural repulsion between oil and water to form ink images on the plates. Large run publications are printed on the web (continuous roll) and can be printed in full colour on both sides of the paper. The inks used are CYMK (Cyan, Yellow, Magenta and Black). In the offset printing process the ink rolls transfer ink to the plate cylinder, which in turn transfers the ink to the offset or rubber blanket cylinder, which in turn transfers the ink to the paper and also protects the paper from water used in the inking process.

In photolithographic printing, the plates are made using a chemical photographic

The Phantasm of Colour

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Family watching TV

process. A similar process is used in the manufacture of printed circuit boards, and micro and nano photolithography are used in microelectronic manufacture.

In printing and photographic work the use of colour can become complex when both additive and subtractive processes are used together.

Modern astronomy utilizes the entire electromagnetic spectrum. Only a very small part of this can directly produce visible images. In radio and microwave astronomy it is necessary to use interferometric methods to obtain images and colours must then be used to show the different wavelengths to advantage. Ultraviolet and X-ray images are also of course invisible and require colour enhancement.

When TV broadcasting first became available this was designed for black and white images.

The broadcast signal had two components, a FM signal for good quality sound and an AM signal which carried the white image pixels scanned line by line (luminance signal). The field refresh rate was coupled to mains frequency so that a 50Hz supply would have a refresh rate of 25Hz. The scanned lines were interlaced over a frame of two fields, (even lines on one field, odd lines on the next) effectively doubling the refresh rate to give a flicker free image. When colour TV was introduced there was an obvious requirement to make the new signal compatible with the old black and white receivers. This was achieved by retaining the image signal and providing a separate colour signal (chrominance signal). The colour signal would carry values of negative colour for each pixel which would then be subtracted from the white value giving the three RGB values to illuminate the screen phosphors. There was no need for a white phosphor as the RGB phosphors would produce white. The colour triangle of the RGB screen phosphors is smaller than the chromaticity diagram of human vision but the colours which cannot be produced usually go unnoticed. The colour range of TV is better than that obtainable from artists' oil colours. The bandwidth required for the composite signal can be up to 8 MHz.

The CRT picture tube is fitted with a shadow mask screen which is perforated with tiny holes, one for each pixel. Three electron guns are used to fire electrons through the shadow mask screen placed near the phosphors of the picture screen. The shadow mask screen has to be installed and later removed during the manufacturing process. Seating lugs at the sides of the tube ensure that the mask is refitted maintaining the very precise alignment.

Electrons passing through the screen diverge slightly, due to the spacing of the electron guns, to illuminate the corresponding colour phosphor. The main disadvantage of the shadow mask CRT is the depth of the picture tube which made the manufacture of very large screens impractical. These TV receivers did however give excellent colour quality and a very long service life so that many of these instruments remain in operation despite the very strong competition from large LCD flat screens.

Three systems of analogue compatibility colour TV are currently in use:

NTSC	National Television System Committee
SECAM	Séquentiel couleur à mémoire
PAL	Phase alternating line

SECAM and PAL were designed to improve on the colour accuracy of NTSC. NTSC is used in countries with 60 Hz power supply and needs a colour control to adjust the colour quality. SECAM is used in France and several countries in Asia and Africa.

In the PAL system a swinging burst is used to compensate for any phase angle shifts in the colour signal. The amplitude of the colour signal indicates the colour saturation and the phase angle with the image signal gives the hue. Even a small drift of phase angle would result in colour distortion. The swinging burst alternately leads and lags the image signal by a fixed amount so that any phase angle drift can be detected and compensated for.

To apply the correction it is necessary to store every second image line. This is achieved by means of a glass delay line. This is a small sheet of glass with two piezoelectric transducers at the edges

which store and retrieve the line signal as multiple reflected sound waves in the glass.

Early receivers were simply fitted with Yagi antennae (Yagi-Uda array) directly connected to the receiver by co-axial cable. There was a curious incident with the Yagi antenna – the Japanese acquired the Yagi design from the Americans without realising that it was originally a Japanese invention. The antennae would be designed for the particular bandwidth and polarization of the transmitter and installed with hopefully no obstructions, or unwanted reflections to give image ghosting. Sometimes in congested areas a reflected signal was the only signal available. The few channels available would be manually tuned on the receiver. This would all change dramatically with dish reception of digital TV from geostationary satellites. The dish signals would be processed by a decoder which could handle hundreds of TV and audio channels and provide astonishing advances in functionality.

The vast resource of 35 mm movies provides an essential supply of material for TV broadcasting. The fields have a higher resolution than HDTV (up to 20 megapixels) and are recorded for projection at 24 Hz. In the PAL and SECAM systems the fields are displayed at 25 Hz which is 4,17% faster than intended, but this is less than a single musical semitone higher and is considered acceptable. For NTSC, showing the movies at 30 Hz was not acceptable, so an ingenious 3:2 pulldown method is used to render the fields and sound as recorded at 24 Hz. The 60 cycles are divided into 12 pairs of 2 and 3 cycles to which the 24 fields are assigned. The 24 fields are then available for 30Hz viewing maintaining the 24Hz input. A TV 'Frame' refers to two interlaced 'Fields'.

The overly complex compatibility analogue TV systems have been superseded by digital TV where no colour compensation is required. The HD (high definition) TV screen carries five times the number of pixels as analogue TV. The standard PAL field size is 704 pixels on 576 lines. With HDTV this is increased to 1920 x 1080 giving 2,07 megapixels per field.

An important aspiration for HDTV was that the already large bandwidth of standard TV should not be increased – this was not to be – HDTV bandwidth is huge reaching into the GHz range depending on numerous factors such as image data compression, stereo viewing, interactive operations and multiple sound channels etc. When analogue TV is phased out, considerable spectrum will become available for digital TV and other purposes. Digital TV signals can be compressed considerably whereas analogue signals cannot be compressed at all. With the conversion of analogue TV to Terrestrial Digital TV the receivers will require a STB (Set Top Box) to decode the signals. This is intended to function using the same antenna previously used by the analogue system.

The newest product to hit the market is UHDTV (Ultra High Definition TV). This monster boasts 7680 x 4370 (32 megapixels) resolution and a screen diagonal of 2,67 m. The bandwidth and price tag are frightening.

In South Africa, TV broadcasting started in 1976 with one channel using the PAL system. Advertising started from 1978 and a second channel was added in 1981. I can remember a TV salesman at the time saying: *"This set has six tunable channels – there is no possibility that more than this will ever be required"*. In 1995 DSTV (Digital Satellite TV) was introduced by MultiChoice. This required the use of a satellite dish antenna and a decoder which offered features such as on line program schedules and program information as well as control of audio channels. In 2008 MultiChoice launched the first HDTV (High Definition TV) channel. In 2012 the new satellite "Intelsat 20" was launched bringing 8 new HD channels. Intelsat operates a fleet of more than 50 satellites which is one of the largest fleets of commercial satellites in orbit.

In 2013, MultiChoice launched the new generation PVR (personal video recorder) Decoder – DSTV Explora, bringing greatly advanced functionality to TV viewing.

Major advances have been made in the storage, transmission and compression of images and video material for use by TV and computers. Significant products are:

JPEG – Joint Photographic Experts Group. This allows for lossy compression of images where compression by as much as 10:1 will show little perceptible loss of resolution or colour integrity. JPEG computer files can be recognized by the '.jpg' extension.

MPEG – Moving Picture Experts Group. This was established in 1988 for the coding of moving pictures and audio. The standard consists of a number of complex parts covering aspects of the whole specification. MPEG provides for huge non-lossy data compression by only transmitting pixels which change from one field to the next.

Analogue TV is to be discontinued in South Africa and several other African countries in 2015, when it will be time to say: *"So long old PAL"*. wn

	Generation/Saved (MW)	Benchmark Rate (R 000,000/MW)	Eskom Budget spent (R 000,000)
Eskom IDM Since 2004 (Energy Efficiency Program)	3 600.00	5.25	18 900.00
Medupi Power Station *(info from http://en.wikipedia.org/wiki/Medupi_Power_Station)*	4 800.00	21.88	105 000.00
		4	

The Virtual Powerstation

It is amazing the amount of data made available by Eskom Integrated Demand Management (IDM) on the success of their energy efficiency program, representing the cost and savings achieved since 2004 in every South African province. Quick research on this data gives us a clear picture of energy efficiency, having a cost over 4 times less than the current cost of new power station build.

BY I HOPE MASHELE I SMSAIEE

Because most of us are not energy nerds who think in terms of kilowatt hours and MegaWatts, it may help to put this in context.

The construction of the "Virtual power station", using world class energy efficiency programs, is a fraction of the current costs of any coal fired power station like Medupi and Kusile, especially since it has been revealed that the country is going to need to build more power stations.

The fact is that smarter uses of energy can replace dirty coal at a fraction of the cost of building coal plants to generate electricity (quicker and without polluting our air/water or exacerbating climate change). This path would also radically quicken the introduction of world class energy efficiency technology and processes in the South African landscape, which will drastically improve productivity levels.

What the country needs is such critical information, put together to help us as a country, as professionals, as regulators i.e. National Energy Regulator of SA (NERSA), Department of Energy (DOE), Department of Trade & Industry (DTI), as private organisations and as individuals, to make smart choices between energy resources.

We have to identify affordable and reliable options (like energy efficiency and green technology) that can reduce emissions from coal power-generating plants, increase productivity plus stave off the worst effects of climate change and economic/social depression.

The results of green technology and energy efficiency programs show the overwhelming value and potential of energy efficiency in every province of the country, across climate zones and industries in South Africa.

The Virtual Powerstation

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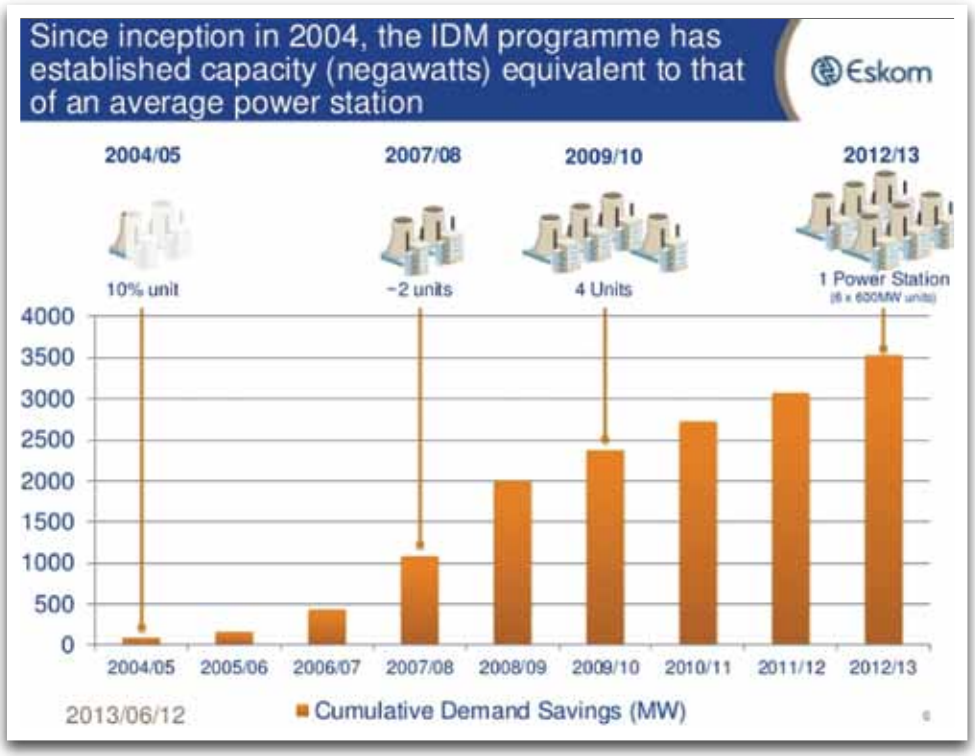


(Eskom IDM Presentation by Andrew Etzinger Senior GM IDM Eskom)

In a period of three years, from beginning of 2007 to end of 2010, Eskom IDM had independently verified savings of over 1 300MW, meaning it is both possible and probable, with "2010 World Cup" focus, to deliver a power station in three years.

The data available is most comprehensive and has been used to develop programs here at home and all over the world, yielding positive and sustainable results in all instances. With energy professionals that have over a decade of experience in energy efficiency, that can dig deep into the (reams) of data from existing programs.

This knowledge would dictate the most effective programs and calculate the value that specific energy efficiency programs can be delivered across the country and industries.

During the past decade, Certified Energy Managers (CEM®), working with private global companies and with Eskom in South Africa, have learnt about the performance of specific types of energy efficiency programs over time. and These numbers are provide an invaluable contribution to making the business case for new, bigger and more focussed energy efficiency programs, that are by far the cheapest (virtual) power generations method, quickest to deploy, and cleanest resource available to every corner of our nation.

An Energy CODESA must agree on an Energy Efficiency and Green Technology Presidential program that must form a substantial portion of the country's response (including new build) to the energy security conundrum in which we find ourselves. We need this focus to save our country, now!

Policy and program alignment which fully recognises energy efficiency and green technology, as major short-to-medium term contributors to energy security, job creation and economic/social upliftment, throughout the regulatory landscape, from DOE, NERSA, the Central Energy Fund (CEF) and Eskom, to the DTI, Council for Scientific and Industrial Research (CSIR), The Technology Innovation Agency (TIA), National Cleaner Production Centre (NCPC), South African National Accreditation System (SANAS), Construction Industry Development Board (CIDB), National Home Builders Registration Council (NHBRC), South African Bureau of Standards (SABS) and the National Credit Regulator (NCR).

Financial institutions from the State-Owned Enterprise (SOE) (Development Bank of Southern Africa [DBSA], Industrial Development Corporation [IDC], Gauteng Enterprise Propeller [GEP], etc) to private institutions with local green funds and foreign donor green funds such as ABSA/ Barclays Africa, Standard bank, Nedbank and FNB must be given the confidence to work with the experience resources of Eskom, CEF and tertiary institutions to quality assure the prospective green projects, to allow an increased and confident investment in these programs.

Public and private institutions must engage thoroughly to avert an economic depression such as we can least afford. Such a possibility can devastate the gain that our country has made in the last 20 years of democracy, setting us back by more than 80 years, returning to the great depression. wn

South African National Committee of the IEC

GO AHEAD, GET AHEAD

YOUR LAST CHANCE TO BE CONSIDERED TO TAKE PART IN THE 2014 IEC YOUNG PROFESSIONALS WORKSHOP IN TOKYO, JAPAN

The South African National Committee of the IEC along with the South African Chapter of IEC Young Professionals is offering young professionals the opportunity to attend the 5th IEC annual workshop for Young Professionals in Tokyo, Japan, November 2014. .

If you…

- Are in your early 20s to mid-30s
- Are a manager, an engineer or a technician
- Work for a company, business or industry using, benefiting from or contributing to the IEC's work

Then apply to be selected now!

ADAM HAMILTON
South Africa 2013

What can participants expect?

- Participate in a dedicated workshop that provides an introduction to the IEC, its standardization processes and conformity assessment systems
- Networking opportunities with professionals from all over the world
- The chance to have your voice heard – outcomes are reported to IEC management
- The opportunity to experience an IEC General Meeting
- An invitation to attend a technical meeting where International Standards are developed
- The opportunity to observe the SMB (Standardization Management Board) or the CAB (Conformity Assessment Board) meeting

To be considered for selection, submit an essay of not more than 5 pages on the subject "Where is there a standards gap" and send it to the National Committee secretariat at iec@sabs.co.za, and cc adam.hamilton@eskom.co.za not later than 30 APRIL 2014.

If you have not already done so, join the LinkedIn Group for the South Africa Chapter of the IEC Young Professionals at http://www.linkedin.com/groups/South-African-Chapter-IEC-Young-7441602?gid=7441602

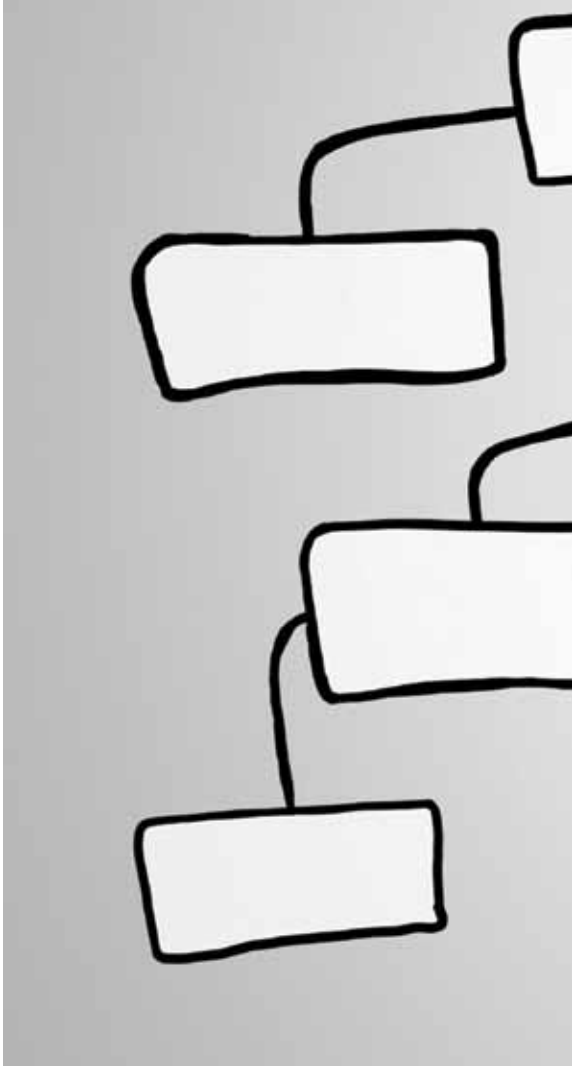
and you will be invited to the launch of the Young Professionals Chapter on 12 May 2014, in Pretoria, where the names of the selected candidates will be announced.

What to expect?

" I truly had a wonderful experience and was able to meet and network with many individuals that can expand my contacts, both professionally and personally. Through talking with other YP's I was able to see the "big picture" scope of the IEC."
CHELSEY SCHWEIKERT
USA

"The IEC YP Program ignited a new passion in me for the world of standards. In no other experience have I met so many people from so many countries that plan and think like I do to make the world a better place."
GERHARD BROWN
South Africa 2013

5 things to keep in mind when choosing a training provider



Many companies see training as a luxury, meaning that it is often one of the first areas organisations cut back on when their budgets come under pressure. As much I believe in the value of on-the-job training, there are certain skills and competencies where formal training programmes and courses can deliver an excellent return on investment for the business.

BY I ANSIE SNYDERS I HEAD OF TRAINING I SAGE VIP

Rather than cutting back on their investments in training when the economy is under pressure, organisations should therefore rather ensure that they're getting quality and value for money from training and education.

That starts with choosing the right training provider and courses.

Here are a few criteria that you can use to ensure delivery of quality programmes.

FIND A REPUTABLE PARTNER

When you're evaluating training providers, take the time to investigate their reputation in the market. Ask each provider you are considering for some reference sites, and be sure to contact them to find out about their

experiences. This will take five minutes of your time, but may save you thousands in training costs.

CHOOSE A SPECIALIST

Find out which trainers will be responsible for delivering the training on the courses you are considering, and evaluate their expertise and qualifications in the subject matter. Someone with a strong, proven theoretical grounding is good; a trainer with practical experience in the field is even better because he or she will be able to talk about real-life situations.

FULFIL SPECIFIC TRAINING NEEDS

Training is expensive, so be sure you know what outcome you expect from your investment in a course or workshop for an employee. Look closely at the course overview and determine beforehand if it will fulfil your need.

If you are choosing training on behalf of your employee, discuss the expected outcome with him or her. Ask the provider for a detailed course outline and discuss how each topic on the list will cover the employee's training need with him or her before the course commences.

LOOK AT THE TAKE HOME VALUE

It's not enough for the training course to deliver practical skills and knowledge that the employee can apply as soon as he or she returns to the office - it must also offer value in the materials the employee gets to take away from the sessions.

Researchers reckon that you remember less than 20% of what you learn during a training intervention. For that reason, a course's value is vastly increased when the employee leaves with reference manuals, online support, and other such tools and materials.

ASSESSING THE LEARNER

The topic of assessments can be controversial. Some people believe they unsettle the learner, while others believe that they're essential to the learning process. Whichever side of the fence you sit on, choose a provider that aligns with your needs.

IN CLOSING

The fact that your training provider has all the right accreditations is not enough on its own to guarantee that its services are of a high quality or that it will meet your needs.

Know what you want from the training and do your homework properly to ensure that you choose the right training partner. wn

WATT?

EXPERT INDUSTRY ADVICE

WATT? is a newly established forum related specifically to the industrial and commercial electrical sector.

Do you have any burning questions, topical issues or points of interest about the electrical industry, from the perspective of a contractor, supplier or professional service provider? Submit your comments, thoughts, ideas, suggestions or questions for the attention of our industry experts, and these will be addressed in a future issue of the magazine. This is your forum, and we would like to hear from you!

The rapid pace of technological change and product development is a global trend that affects entire economies. We may have access to more information than ever before, but is this information readily understandable? Does it give us insight into the fundamental issues? Is it precise and based on technical clarity?

WATT? is an opportunity for people on the ground to engage with each other and related professionals in an informative and friendly manner. This is a platform for you to discuss anything related to your particular sector, to highlight anything new, or to ask a specific question related to a technical topic or to engage in general industry issues. . Please note that we will not be considering anything related to the domestic sector, such as residential wiring.

We hope that this section of the magazine not only becomes a regular feature, but that it is widely read and distributed among your peers. Remember, it can only become a success with the full participation of our readers! Send your burning questions to minx@saiee.org.za - subject 'WATT?'.

We look forward to hearing from you.
- Ed

QUESTION ONE

What South African National Standard (SANS) specifications must I include related to Variable Speed Drives (VSDs) to ensure that the equipment complies with the required South African standards?

ANSWER

There are several SANS and international standards related to VSDs listed below. If the user lists these specifications, compliance with the applicable local and international standards is assured.

It is important to be aware that full compliance often requires certain installation and application practices. Purchasing a compliant product ensures that the product alone is compliant. To ensure full compliance, the system design and installation must also follow the applicable standards.

The user should also consider his application requirements and the features, reliability and support of any product under consideration. Some compliant products are very difficult to use and poorly supported. List of applicable local and International standards. *Note: There are other standards that make reference to VSDs. However, they are not specific to VSDs.*

SANS 61800-2:
Adjustable speed electrical power drive systems- Part 2: General requirements – Rating specifications for low voltage adjustable frequency AC power drive systems;

SANS 61800-3:
Adjustable speed electrical power drive systems – Part 3: EMC requirements and specific test methods;

SANS 61800-5-1: Adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy;

SANS 61800-6:
Adjustable speed electric power drive systems – Part 6: Guide for determination of types of load duty and corresponding current ratings.

SANS 60146:
Semiconductor converters
NRS 048 - Electricity supply – Quality of supply standards.

EN 50178:
Electronic equipment for use in power installations;

IEC 60146:
Semiconductor converters

IEC 61800-2:
Adjustable speed electrical power drive systems - Part 2: General requirements - Rating specifications for low voltage adjustable frequency a.c. power drive systems;

IEC 61800-3:
Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods;

IEC 61800-5-1:
Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy;

IEC 61800-7:
Adjustable speed electrical power drive systems – Part 7: Generic interface and use of profiles for power drive systems

IEC 61000-2-2 Environment:
Compatibility levels for low-frequency conducted disturbances and signaling in public low voltage power supply systems

IEC 61000-2-4 Environment:
Compatibility levels in industrial plants for low-frequency conducted disturbances

IEC 61000-3-2: Limits for harmonic current emissions (equipment input current ≤16A per phase)

IEC 61000-3-4: Limitation of emission of harmonic currents in low-voltage power supply systems for equipment with rated current >16A

IEC 61000-4-2:
Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test;

IEC 61000-4-3:
Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test;

IEC 61000-4-4:
Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test;

IEC 61000-4-5:
Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test;

IEC 61000-4-6:
Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields.

UL 508C:
Power Conversion Equipment;

EN 60204-1:
Appliance of reference designations on machinery in accordance with ISO/IEC/EN 81346;

EN 60529:
Degrees of protection provided by enclosures (IP code);

EN 55011:
Limits and methods of measurement of radio disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment;

EN 60529: Degrees of protection provided by enclosures (IP code).

UL 840:
Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment;

UL 50:
Enclosures for Electrical Equipment, Non-Environmental Considerations.

CISPR 11:
Industrial, scientific and medical (ISM) radio- frequency equipment Electromagnetic disturbance characteristics Limits and methods of measurements;

IEEE 519: IEEE Recommended practices and requirements for harmonic control in electrical power systems. wn

Answers provided by Zest WEG Group

February

COMPILED BY | JANE BUISSON-STREET
FMSAIEE | PMIITPSA | FMIITSPA

STAR SIGN: ACQUARIUS

You just don't want to be like others and take pride in the fact that you're so unique. Even if you're occasionally criticized for your cheeky attitude, you'd far prefer to be self-sufficient rather than being a sheep in society who follows everyone else's lead.

1 February

2008 Microsoft put a bid in for Yahoo! This was not the first time Microsoft had made a play for the company. Yahoo! would eventually decline the offer of Microsoft, claiming they undervalued the company.

2 February

1964 The first G.I.Joe, a 12-inch soldier, was released to the toy market. The word "Doll" was avoided to keep the stigma away that boys played with dolls.

3 February

2000 The Ford Motor Company announces that it will give each of its 350,000 employees a free Hewlett-Packard HP computer and discounted Internet access. According to Ford Chairman William Clay Ford, Jr. *"The Internet will be the equivalent of the moving assembly line of the 21st Century."*

4 February

2004 Mark Zuckerberg launched The Facebook - which would eventually become Facebook, an online social networking service.

5 February

1958 The US Air Force lost a hydrogen bomb, known as the Tybee Bomb, off the coast of Savannah, Georgia, which has not been recovered.

6 February

1971 Apollo 14 astronaut Alan Shepard became the first person to hit, not one but, two golf balls on the Moon.

7 February

1984 NASA astronauts performed the first untethered spacewalk using the Manned Manoeuvring Unit. The two astronauts were members of the space shuttle Challenger's crew.

8 February

1974 The final Skylab crew came home after sighting Comet Kohoutek (a long-period comet), recording the birth of a solar flare from space, and unexpectedly taking photos of Area 51.

9 February

1997 The Simpsons, the animated television sitcom, aired its 167th episode and surpassing The Flintstones to become the longest-running animated series in history.

10 February

1999 Intel introduced the Pentium III processor in Cannes, France. The new processor offered speeds of 450 – 500MHz. It was officially released 17th February.

11 February

1983 President Ronald Reagan proclaimed February 11 to be National Inventors' Day in the United States, a date chosen in honour of the birth of Thomas Edison.

12 February

1961 Venera 1, the first spacecraft to fly past Venus, was launched by the Soviet Union after a similar, unsuccessful attempt was made just days before.

13 February

1967 American researchers discovered the Madrid Codices by Leonardo da Vinci. The two volumes proved da Vinci's talents as an engineer and include about 15% of his notes that are still referenced today.

14 February

1989 The first of the twenty-four satellites of the Global Positioning System (GPS) was placed into orbit.

15 February

1946 The US Army announced that ENIAC (Electronic Numerical Integrator And Computer), the first electronic general-purpose computer, was being constructed. The computer was to be programmed to calculate artillery-firing tables intended for use during World War II. However, it took approximately one year to design ENIAC, and another 18 months to build, so by the time ENIAC was completed, WWII was over.

16 February

1923 Archaeologist Howard Carter opened the sealed doorway to the sepulchral chamber of King Tutankhamen's tomb in Thebes, Egypt.

17 February

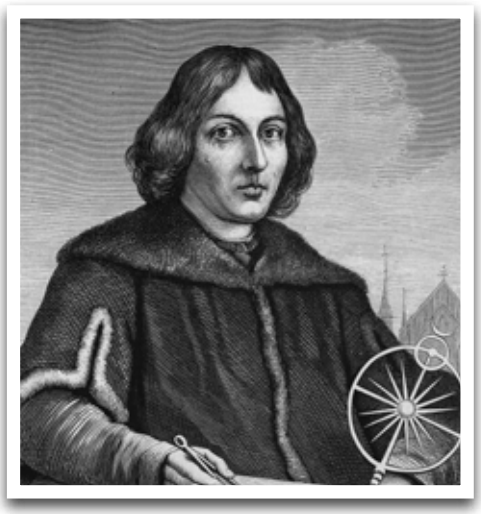
1911 The first self-starter, based on patented inventions created by General Motors engineers Clyde Coleman and Charles Kettering, was installed in a Cadillac.

18 February

1876 A direct telegraph link was established between Britain and New Zealand.

19 February

1473 On this day in tech history, Nicolaus Copernicus was born, beginning a life that would see the Renaissance mathematician and astronomer formulate a comprehensive heliocentric model of the universe.



20 February

1962 John Glenn became the first American to orbit the Earth, spending 4 hours and 56 minutes in flight in Mercury spacecraft Friendship 7 as he circled the Earth three times.

21 February

1947 Polaroid founder, Edwin Land, demonstrated the first instant at a meeting of the Optical Society of America in New York City. The Land camera, as it was originally known, contained a roll of positive paper with a pod of developing chemicals at the top of each frame.

22 February

1997 Scientists at the Roslin Institute in Scotland announced that they had cloned an adult sheep. Originally code-named "6LL3," she was named after Dolly Parton because the donor cell used was taken from a mammary gland.

23 February

2006 iTunes sold its one-billionth song, Speed of Sound, from Coldplay's X&Y album.

24 February

1997 Walt Disney and Pixar enter into a 5 movie agreement in 10 months. They would share costs, profit and logo credits. The two would come into issues after Toy Story 2, which ultimately were resolved in 2006 when Disney purchased Pixar.

25 February

1836 After receiving a patent in England in 1835, American inventor and industrialist Samuel Colt was granted US patent 9430X for a "revolving gun" on February 25, 1836.

26 February

1946 Ghost rockets, rocket- or missile-shaped unidentified flying objects (UFOs), were first sighted in Sweden and nearby countries.

27 February

1910 Clarence Leonard "Kelly" Johnson, an American system engineer who was responsible for the initial construction of the site now known as "Area 51", was born.

28 February

1959 Discoverer 1, the first of a series of US satellites that were part of the Corona reconnaissance satellite program, was launched. The Corona program was established to watch over the Soviet Union. wn

IN MY OPINION : JAYNE ARCHBOLD

Why Mentoring Matters

Confidence is a precious thing in business. Having the confidence to succeed, the belief in yourself that your ideas will work and the drive to turn those ideas into reality are key traits of the high-achieving entrepreneur.

BY I JAYNE ARCHBOLD I CEO I SAGE MID-MARKET

But how confident can someone be when they confront new strategies for growth or realise that they are going to have to try something different to help them succeed in their role? Where can they turn to for advice and guidance?

For me this is where a business mentor can really make a difference. There has been a lot of talk about mentoring over the past couple of years and Sage has done some research recently which showed that, while almost everyone thinks business mentoring delivers benefits, not that many people are actually going out and using a mentor.

Mid-market businesses across Europe are failing to take advantage of business mentors, despite the vast majority recognising that external advice would help their organisation succeed, I found in a survey recently.

While 93% of firms agreed that business mentoring was helpful or useful to their organisation, on average just a third (33%) actually made use of a business mentor, the research showed. For the poll 1,825 decision-makers in mid-market businesses were interviewed in 17 countries.

One of the problems is that there is still some confusion as to what a mentor is or does. I think the best basic definition is along these lines: Mentoring is a professional relationship between a more experienced person (the mentor) and a less experienced person (the mentee) where the mentor helps the mentee to develop knowledge and skills that improve their professional expertise.

I would further say that the key fact in business mentoring, as opposed to business coaching, is that the mentor has the specific business experience that is relevant for the mentee's situation. A business coach has a wider, less specific set of skills and methodologies for helping a mentee.

So what are the benefits of mentoring? The most important one is that a mentor brings a degree of objectivity to the business decision-making process that may not exist within the business.

Objectivity is often undervalued, especially by owner/founders of businesses. When people set up in business, they bring passion and creativity and a particular sense of purpose. But that focus can get too narrow, especially as the business grows and looks to expand. In bigger organisations that ability

to look from the outside – often from the customer's point of view – is especially valuable. A mentor can bring that bigger picture view and help surface problems and solutions that would have been overlooked otherwise.

This outside-in view can have a significant impact over business success. According to the Department for Business Innovation and Skills in the UK nine out of ten businesses who had worked with a mentor said it had a positive impact on their business. It also found that nearly twice as many mentored businesses reported an increase in turnover compared to unmentored businesses.

With this strong evidence of the benefits, why the hesitation? I think that one of the most significant block for small and medium business owners using a mentor is, simply put, time. The best mentors save businesses time, effort and money by helping them to focus on what works using the benefit of their experience.

What should you be looking for in a mentor? Here are some of the top characteristics:

- A mentor who has experienced both success and failure. They will have more to share.
- Experience in your sector or industry. This means the advice will be targeted and relevant.
- Someone who you can get along with. You need to find a mentor who aligns with your values, otherwise you will end up clashing.
- Someone with whom you can build a long-term relationship. The best mentor/mentee relationships can be productive for years.
- Someone who is honest and direct. You don't need a cheerleader, you need someone who will give you straight advice.

I think that businesses that do not have access to, or choose not to make use of business mentoring are at a disadvantage. In our information rich age it can be difficult to know if you are doing the right thing. Mentors can play a big role in helping businesses to navigate the sea of advice on offer.

Finally, a word about seeking advice and support from outside the business in general. Medium-sized businesses should not be afraid to seek outside help from experts. There are a lot of providers that can help externally with business problems such as HR or marketing or growth strategies. Many businesses do not have the in-house expertise and when time is tight and the objectives clear, then seeking consultancy from agencies or other bodies can really deliver. At the same time, using outside consultants can help train your own staff so they can replicate the skills themselves and drive them through the organisation.

I am not suggesting that this should be a huge investment but often mid-market companies overlook the advantages of outside agency help, believing wrongly that this is something that only big corporates can afford. WN

The SAIEE offers mentorship programmes. For more info, contact Sue Moseley via email - suem@saiee.org.za.

The ugly truth

'In this world nothing can be said to be certain, except death and taxes…….and a steadily widening waist line.' - *Benjamin Franklin (+Angela Price).* It's an ugly truth that many of us are facing - belt notches inch out as calendar months creep by.

BY I ANGELA PRICE

Forget the mirror, children are the most honest gauge of our age(ing). *"Mommy your skin looks like nana's" "That's a beautiful dress mommy… oh and you look ok too."*

Children that I have known for years frighten me the most. It honestly feels like yesterday that I was watching them learn to walk and next thing I am wishing them a happy 9th birthday day. Stupidly I find myself thinking, *"It can't be 9 years …"* And yet it is. *"But I haven't aged a day"*, I muse to myself. And that self-delusion works for a while - until you try and squeeze into a pair of jeans you wore 'just the other day'. *"Water retention?"* you think hopefully.

This soul destroying discovery gave rise to a very sudden interest in instrumentation (note I said interest and not obsession ok?) By dictionary definition instrumentation is …'the use of measuring instruments to monitor and control a process. It is the art and science of measurement and control of process variables within a production, laboratory, or manufacturing area'.

Translated into my easy- to- understand, situation- specific terms it could read as… The use of a scale to monitor much needed weight loss, following a low carb, higher fat consumption process. It's is the art and science of carefully controlling and balancing the amount and type of food I eat vs. what I burn up whilst maintaining a happy, healthy existence.

- My measuring tool of choice is of course the bathroom scale.
- The process I have chosen to follow is a low carb, higher fat methodology, aka the Tim Noakes lifestyle, not diet (hold your comment folks).
- Process variables would be the amount I eat and the amount I burn off.
- My laboratory is the kitchen.
- Aim = weight loss and better health.

It goes without saying that process controls must be rigorous to ensure true success, therefore:

- Always use the same scale,
  - Personally I like my home scale as it is 2 kg's lighter than the one at the gym and is carefully calibrated -with a foot nudge - daily (of course my home reading is my true and accurate weight);
- Weigh yourself at the same time each day - Preferably as soon as you wake up (after you have visited the toilet);
- Make sure you are wearing the same thing every time you weigh in;
- Ideally your birthday suit (earrings, watches and rings all add up so jettison them too).

Much like everything else technology in this particular area of instrumentation is advancing all the time - as is my waist line. But without a doubt weight measurement has historically always been a demoralizing affair, think back….

The playground see-saw - always a good weight indicator (remember that moment when the other kid gets on, you optimistically push off - only to plummet straight back down with a spine jarring thud?)

Then there's those caliper thingies which you use to grab and measure your flabby bits - enough said.

And it wasn't all that long ago that most of the gyms had those mortifying balance scales used for weighing oneself…..how vividly I recall optimistically hoping onto those scales and setting a 'hoped for' weight on the markers, only to find myself having to slide the weight indicator further and further along, continuously adding more weight until the scale balanced and delivered its heart breaking verdict (whilst half the woman in the change room surreptitiously looked on with glee).

The digitized scales used now have lessened the public humiliation but pack their own 'below the belt' punch with info regarding body fat vs muscle rations, BMI, progress reports - all too depressing for words really.

Now, if someone could only invent an instrument which could accurately pin point the date of my guaranteed demise I am quite certain I would spend more time living and less time weighing things! wn

Calendar of events

If you want to see your function or event listed here, please send the details to Minx Avrabos at minx@saiee.org.za

FEBRUARY 2015

9	Electric Power Cables Tutorial	SAIEE House, Johannesburg	www.saiee.org.za
24	Project Management	SAIEE House, Johannesburg	www.saiee.org.za
24-25	2nd Annual Cable Anti-Theft Technologies Summit	Emperor's Palace, Johannesburg	www.mogorosicomms.co.za
25	Photovoltaic Solar Systems	SAIEE House, Johannesburg	www.saiee.org.za

MARCH 2015

11	Advanced Microsoft Excel For Engineers	TBC	www.saiee.org.za
24	Revision Of Power System Fundamentals	TBC	www.saiee.org.za
24	Power & Electricity World Africa	Sandton Convention Centre, JHB	www.terrapinn.com
26	SAIEE Annual General Meeting	TBC	www.saiee.org.za

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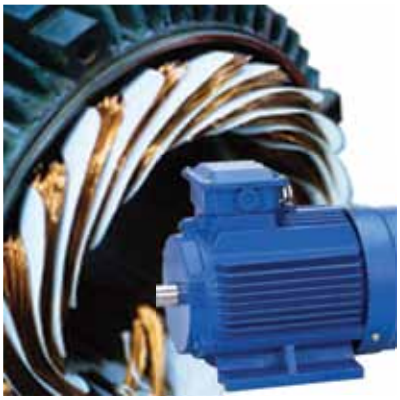

Equalizer-ST System Overview

The EQUALIZER-ST is a real-time, dynamic reactive power compensation system that utilizes a proven industrial technology to provide an additional solution for the challenges related to large motor startups. The system itself operates at low voltage and by utilizing a step-up transformer, the EQUALIZER-ST is also able to to compensate for medium voltage networks.

Centralized Motor Startup Compensation

The EQUALIZER-ST is a centralized motor startup solution, that provides fast compensation in real-time. In an environment of many motors, one EQUALIZER-ST system serves any number of motors, assuming that two motors are not started simultaneously. Eliminating the need to use individual soft start devices for each motor, makes the EQUALIZER-ST more cost effective than conventional compensation systems.

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