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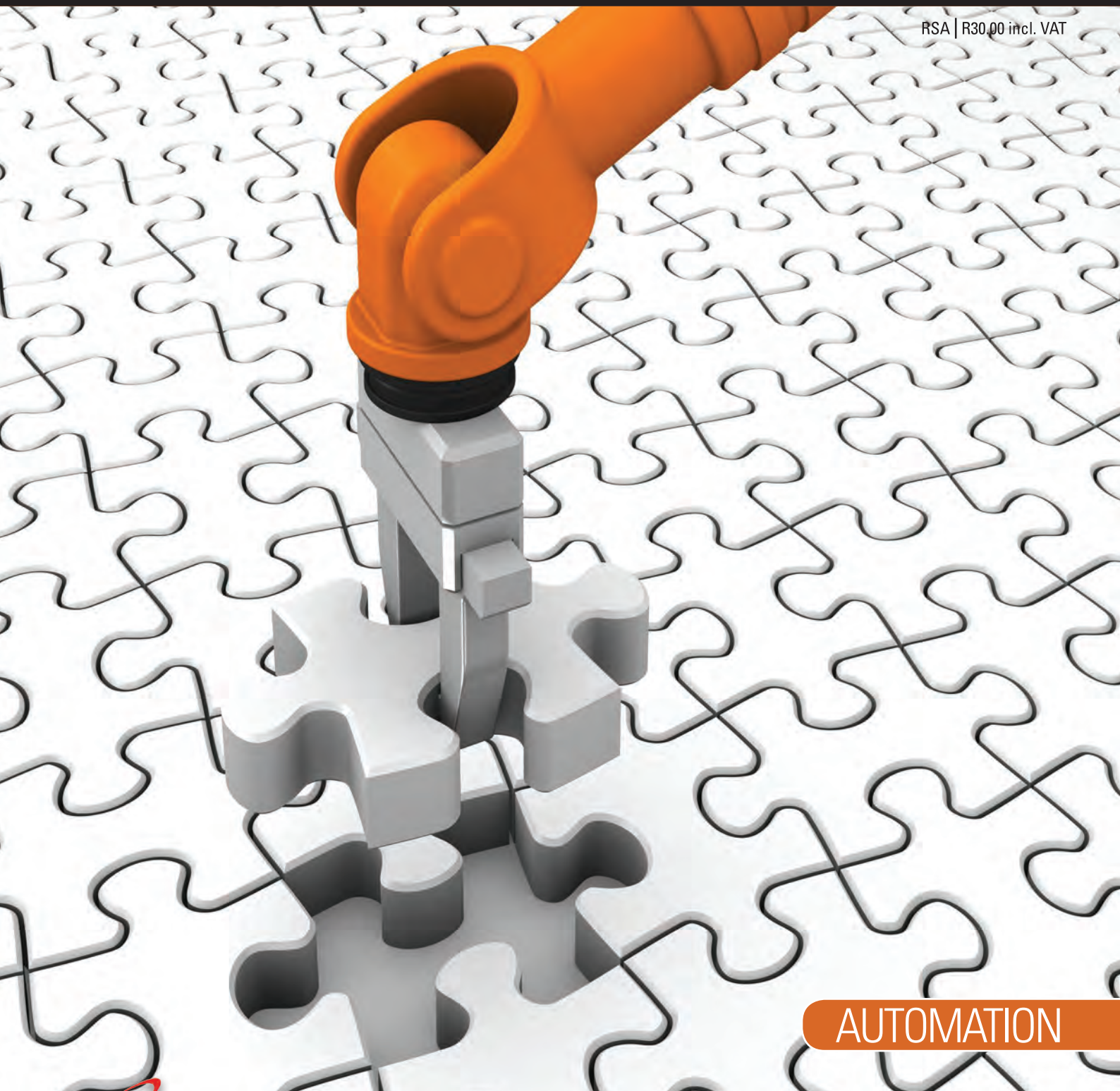

AUTOMATION

SAIEE THE OFFICIAL PUBLICATION OF THE SOUTH AFRICAN INSTITUTE OF ELECTRICAL ENGINEERS | **JUNE 2017**

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June is here - the days are shorter and the nights are becoming longer - well, for some of us. You'd never say we are having winter, with the maximum temperatures around the mid-20's in Johannesburg. It's rather nice.

I share with you feedback on my recent Israel trip - an experience I will never forget. Read more on page 20.

This issue of **watt**now features Automation, with the first feature article on Robotics. AfrikaBOT is a Robotics Competition taking place in October 2017 in Township schools. Read more about the story behind AfrikaBOT on page 26.

Page 32 features an Automation article, discussing Indoor Autonomous Mobile Robots. We look at the difference between 'autonomous' and 'mobile' robots.

We look at "Analysing Ribbon Bond in Silicon Solar Cells" on page 40. Technology and requirements have changed in the last few decades, and to stay abreast with technology and demand, this test was done.

The SAIEE runs an online CPD program. We give you more information on this on page 44.

Page 48 gives you a lovely article written by Dudley Basson. He never disappoints with his take on the Cassini-Huygens Mission to Saturn! A fantastic read.

The July issue features 'Nature' - anything to do with Solar, Wind, Earth, Fire, Lightning. If you have an article 'gathering dust' on your computer, send it to me. You never know, you might just earn a CPD credit for your submission.

Herewith the June issue, enjoy the read!

Minx

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Visit www.saiee.org.za to answer the questions related to these articles to earn your CPD points.

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SmartGRID CONFERENCE

SAIEE

19 – 21 Sept | Service Delivery for a **Smarter** Africa

Eskom Conference Centre | Registration opens on **9 March 2017**

Only 300 seats are available.

The 2017 Conference draws on the success of the inaugural Conference that was held in February 2016, but has expanded to include a much wider eco-system including topics such as Smart Cities, the Internet of Things (IoT) and the Fourth Industrial Revolution. The program will also draw on plenary speakers from a number of the BRICS countries, in addition to speakers from Europe and the US.

www.saiee-smartgrid.co.za

"The first rule of any technology used in a business is that automation applied to an efficient operation will magnify the efficiency. The second is that automation applied to an inefficient operation will magnify the inefficiency".

JACOB MACHINJIKE
2017 SAIEE PRESIDENT

It is an honour to be of service.

The **watt**now theme for this month is 'automation'.

Bill Gates once said, and I quote, *"The first rule of any technology used in a business is that automation applied to an efficient operation will magnify the efficiency. The second is that automation applied to an inefficient operation will magnify the inefficiency".*

In my Presidential address I touched on aspects of the role of the engineering professional in complex decision making. Challenges are many and that presents our call to action. Engineering practitioners should immerse themselves in all aspects of society and help come up with the required solutions. You are problem solvers. The internet of things provides huge opportunities for us to do things in better, faster and cheaper ways. I am looking forward the SAIEE/Eskom co-ordinated Smart Grid conference of 19th-21st September 2017. Let us make this conference a success on our journey to make South Africa, and southern Africa, great.

The weeks and months ahead are very important in the political space and the governance of various organisations. Communities require service provision and we should pay attention to this for a stable society. South Africa is in a technical recession, and concerted efforts should go towards stimulating the economy. One area to assist in reversing the negative economic growth, is to build investor confidence. We need more good news stories and we should not magnify bad stories due to the 'automative' nature of social media. We require concerted efforts to think, speak and act positively about our country. The world should see us in positive light, in terms of what we have achieved, and what we can become.

SAIEE, its members and corporate partners have an important role to play in the provision, growth, development and sustenance of the much required skills to grow the economy and to resolve society's challenges. Thank you for your support and involvement in making a meaningful contribution.

J Machinjike| SAIEE President 2017
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WATTSUP

CONCO's success gained in SA renewable energy market opens doors

A wind farm for which CONCO undertook the electrical BOP and grid connection.

CONCO, Africa's largest power infrastructure service provider with 30 years' Africa-wide experience in transmission, distribution and power infrastructure development, has successfully completed the electrical balance of plant for over nine wind farms and four solar photovoltaic (PV) parks in South Africa including grid connections. This work forms part of the South African government's renewable energy independent power producer procurement (REIPPP) programme.

REIPPP PROGRAMME - WIND

For bid windows one, two and three, CONCO secured the electrical balance of plant work of 68%, 40% and 70% respectively, of the total megawatts allocated per window. The company's expertise encompassed wind turbine reticulation where it connected over 300 turbines to the grid, wind turbine pad-mounted transformer kiosks, facility SCADA and power plant controller solutions, network stability equipment required to ensure grid code compliance, substations and overhead lines. CONCO's services included in-house design, commissioning and project management.

Despite the challenges and risks involved, all wind and solar projects were completed within the specified time and CONCO further proved its reliability as a trusted supplier by complying with the economic development obligations pertaining to jobs, local content and preferential procurement. This marks CONCO's success in handling large scale complex renewable energy projects. The company plans to take this extensive experiential base in renewable projects into the rest of the continent.

It also opens doors for CONCO to expand into other IPP projects such as oil, gas, nuclear and co-generation.

SOCIAL RESPONSIBILITY

Renewable energy projects, like any other CONCO projects, have a social responsibility aspect to them. Examples include the donation of science laboratories to a school where CONCO also conducted teacher training in order to help improve maths and science, as well as the refurbishment of an entire school and crèche.

Latest EtherCat solutions, IOT devices from Omron take centre stage at African Automation Fair 2017

Omron's EtherCat solutions and Internet of Things (IOT) devices took centre stage at the African Automation Fair (AAF) recently.

There were a strong emphasis on Omron's Sysmac motion solutions, comprising robotics and visual inspection control, Victor Marques, Country General Manager, highlights. *"Historically, AAF has always had a good reach into all of our relevant industries. Of course, we also have the correct target market attending our stand."*

The scope of AAF 2017 has evolved with the inclusion of IOT as one of the latest and most pervasive trends in the automation industry. Many organisations already focus on how to benefit from it, but extracting maximum value requires a big data approach.

Marques highlights that Omron's presence has appealled directly to customers on the lookout for cost-effective and highly-innovative solutions that meet, and even exceed, their requirements. *"We are looking to target OEMs in particular, and food & beverage end-user customers,"* Marques points out.

Sustainable development can be enabled by decolonisation of knowledge, says UJ's Prof Saurabh Sinha

At the height of #FeesMustFall, disgruntled students challenged leaders of the University of Johannesburg on what it is that universities are doing to decolonise knowledge. When they started discussing it, it became obvious that there was no consensus on what students meant by that, said Prof Saurabh Sinha on Wednesday 10 May 2017 at the Bunting Road Campus of the University of Johannesburg (UJ).

From left: Mr Mabuza, INCOSE; Mr Motsoasele SAIEE; Ms Cornelius, SAIEE; Prof Sinha, UJ and IEEE; Mr Setlhapelo, SAIEE; Prof Naidoo, UJ and SAIEE; Mr Oosthuizeen, INCOSE SA; Mr Ramutumbu, SAIEE.

He was the keynote speaker at a public lecture organised by engineering professional bodies, INCOSE and SAIEE.

Prof Sinha is the Executive Dean of the UJ Faculty of Engineering and the Built Environment, as well as IEEE Educational Activities Board Member and co-founder of the IEEE Engineering Projects in Community Service (EPICS-in-IEEE) programme. *"In November 2015 while protest actions were taking place, I had the opportunity to speak with one of our students at UJ. I said 'why do you propose #feesmustfall for all?' I know of some individuals who would be able to fund their children's university education,"* said Sinha.

The student explained that he has to convince people that he is worthy of higher education and that he needs sponsorship. He said that applying for a student loan requires that you disclose the extent of your poverty, which takes one's dignity away. *"It becomes clear that the access to higher education is really restricted in South Africa, particularly for some with high potential. As an example, UJ received over 120 000 applications for first-year admissions for 2017."*

The income and fees reality is that in South Africa, as of 2016, the top 1% of earners hold 19% of the income in the country, according to the World Wealth and Income Database. However, though popular demand asks for it, a large enough national budget to provide services such as universal university education for all, is not available. So the enormous challenge is to provide services to these people at reasonable cost, he said, which makes innovation critical. And yet, there is a very successful example of providing essential services to poor and isolated people. In this case, there were no affordable centralized services available to many. By decentralising the delivery of required infrastructure, mobile phone services succeeded in reaching even remote locations on our continent. Mobile telephony spread incredibly quickly across the globe, including Africa, using a hybrid of existing technologies and roll-out mechanisms.

"This success points to a potential overlap between decentralisation, sustainable development and decolonization of knowledge", said Prof Sinha. Similarly, it has been shown in water and electricity provision, that engineering innovation to produce low-tech solutions can offer high-impact solutions. In this approach, centralisation is not replaced. Rather, the idea is to develop complementary and hybrid technological solutions for sustainable development to the poorest in our nation. *"In this way, we can, at reasonable cost, reach those who are most underserved in South Africa and other parts of the continent,"* he said.

"The challenge to provide universal higher education can become overwhelming. But this is where one needs to be the change, instead of waiting. We can't wait for government to develop a policy or a framework. We can't wait for industry."

"Instead, our thinking is to act, delivering new initiatives through sustainable partnerships. An example of this is to gradually infuse final year and postgraduate projects with community service components. In this way, research and development can be embedded in society through engineering students implementing projects with communities to meet their needs," he said. *"The multidisciplinary approach then brings about the development of knowledge from communities and thus also contributes to contextualised knowledge production inclusive of socio-economic, techno-economic and cultural context,"* said Sinha.

UJ is exploring models for a full range of online courses for undergraduate and postgraduate studies, to further develop accessibility to higher education. *"These are tough economic times requiring us to be innovative. We must seek to be locally relevant and internationally competitive. The decolonisation of knowledge expands our approach to be locally relevant yet internationally competitive"* concluded Prof Sinha.

WATTSUP

Trafo Brings Advantages Of Dry-Type Transformers To Africa

Modern manufacturing efficiencies and greater market demand has narrowed the price gap between dry-type transformers and traditional oil-filled units, giving customers around Africa the opportunity to benefit from the many advantages of tried and tested dry-type technology.

According to Trafo Power Solutions managing director David Claassen, these transformers are safer and more efficient than their oil-filled equivalents, factors that make them a cost effective and versatile choice in a range of applications and sectors.

"The high safety rating of dry-type transformers allows them to be installed indoors, avoiding the cost and inconvenience of the special structures normally required to accommodate the safety and environmental hazards related to oil-filled units," says Claassen.

The rise in awareness of safety at work in all sectors of the economy has led to greater utilisation of safer technologies like these. *"Dry-cooled transformers are categorised as F1 in terms of international fire resistance ratings, making them low-risk as they are self-extinguishing and flame-retardant by nature,"* he says.

The technology also serves a growing demand for more energy-efficient solutions, especially as the price of electricity has risen dramatically in South Africa and many economies on the continent.

"End-users will benefit from the reduced energy consumption of these transformers, which is another factor that has attracted attention to these units in new and existing markets," he says. *"The higher efficiency of the cast resin design means lower electricity bills, and also lowers heat losses. These units therefore require only a minimal movement of air across the windings to cool them down, although forced air options can also be employed where necessary if ambient temperatures are high."*

David Claassen, Managing 14 irector of Trafo Power Solutions.

Less maintenance is another advantage; dry-type transformers are low in maintenance and could last for 25 years without significant attention, while oil-filled transformers require regular maintenance including oil sample analysis to ensure operational consistency and safety.

New Fluke electrical loggers can help reduce facilities' energy costs

One of the most significant costs at industrial facilities is energy. While many managers view energy as an unavoidable expense, in reality it is a variable cost that can be monitored and managed, significantly improving the bottom line.

Fluke, locally represented by Comtest, now has the Fluke 1732 and 1734 Three-Phase Energy Loggers - powerful tools that are designed to more easily identify sources of electrical energy waste. Easy to set up and use, and capture key measurements — voltage, current, power, power factor, and other variables like temperature, the 1732/1734 enable managers to understand their energy usage and correlate it to their activities. The new loggers are also Fluke Connect® compatible. Data can be viewed from anywhere via the Fluke Connect mobile app, potentially reducing the number of times a technician must open a panel while wearing full protective equipment.

The new Fluke 1732 and 1734 Three-Phase Energy Loggers are powerful tools that are designed to more easily identify sources of

electrical energy waste. These new loggers are easy to set up and use, and capture key measurements - voltage, current, power, power factor, and other variables like temperature - to enable managers to understand their energy usage and correlate it to their activities.

Elsie Pule Awarded SAIEE Companion

At the SAIEE Power and Energy Section meeting held on Thursday on 1st June 2017, Stan Bridgens, CEO presented a Certficate of Companion Membership to Elsie Pule, ESKOM HR Group Executive.

This prestigious award (of which currently there are only four) is by invitation of the SAIEE Council for any person who has rendered important services to, or to the benfit of, electrical engineering in commerce, finance, law, science or other activities.

Elsie was instrumental in directing Eskom resources in the ground breaking SAIEE initiative, together with the Nelson Mandela Metropolitan University (NMMU) and the Durban University of Technology (DUT) in providing the P1 & P2 Work Place Experience portion of their tertiary curriculum enabling them to graduate.

This scheme designed specfically to address the skills shortage in SA, would not have been possible without the assistance and cooperation of ESKOM and the Tertiary Institutions that involved a tripartite agreement. To date, this scheme has enabled about 110 candidates to acquire the required experience in the work place.

The potential to expand this arrangement with other employers is huge, in the drive to providing skilled and competent engineers, technologists and technicians for South Africa.

From left: Elsie Pule, SAIEE Companion with Stan Bridgens, CEO - SAIEE.

The SAIEE is indeed fortunate to have Elsie Pule as a Companion - this professional association with other employers augers well for serving the Electrical Engineering fraternity.

CESA celebrates a decade in unearthing future engineers

In its quest to promote engineering as a career of choice, Consulting Engineers South Africa (CESA) and its Young Professionals Forum (YPF) has for the past decade celebrated Job Shadow Day with the aim of attracting South Africa's learners into becoming the country's future engineers.

The initiative is geared towards showcasing the engineering profession, particularly consulting engineering as an exciting career option and also serves as a call to action for Engineering Corporates to develop a pipeline of much needed engineering professionals in South Africa.

CESA's YPF Chairperson Amanda Masondo-Mkhize points out that June is a significant month that is used to commemorate the role of youth in the liberated society that we live in today. *"To ignite and commemorate the resolve of those gallant students. I would like to urge all CESA member firms to partake in the Job Shadow Initiative and allow high school pupils to experience 'A day in the life of a Consulting Engineer'."* proclaims Masondo-Mkhize.

Since 2008, CESA's Job Shadow Initiative has reached over 15 000 learners from previously disadvantaged backgrounds. In 2004 CESA established a young professional forum to expedite the development of practicing young professionals by creating focused platforms of interaction that could be utilized to address areas of development that were identified as lagging by these young practitioners.

The Job Shadow Initiative takes the form of a poster competition, from which the three best posters describing the learners' experience having spent time with a member company receives the recognition at the CESA Aon Engineering Excellence Awards, which will be held on 16 August 2017.

In 2016, Royal HaskoningDHV was the winner of the CESA Job Shadow Poster Competition with UWP Consulting and Nako ILISO as the runners-up.

For more info, visit www.cesa.org.za

WATTSUP

High Efficiency Motors Are Big Cost Savers

As Africa's mines work to hold down costs and extract more value from their assets, modern high efficiency motors from Zest WEG Group are helping to cut energy bills and maintenance.

Almost two-thirds of the power consumed by the mining sector is associated with electric motors, so these items of equipment are important for mines to look at when demanding savings, according to Zest WEG's Group African business development executive, Edson Cristofolini.

"Where an old 55 kW motor is operating 24 hours a day and seven days a week, we estimate that a mine can save over to 20 MW a year by replacing it with a new WEG Top Premium Efficiency IE3 motor," says Cristofolini.

These savings add up when considering how many motors are operational on a large mine, he says. Apart from reducing energy consumption, the WEG IE3 motors also contribute to mine profitability through their long life, low maintenance and reliability.

"Repairs and replacements are especially costly and time consuming for mines in remote locations, so these motors are designed to operate reliably under harsh operating conditions," he says. *"An important aspect of the design in the WEG Top Premium Efficiency IE3 range, for instance, is the Class H Insulation with class B temperature rise."*

This provides a buffer of 60°C between the motor windings average operating temperature and the actual motor insulation capability, protecting the motor where quality of power varies or where ambient temperatures are very high.

This robust design also provides a service factor of 1.15, allowing a motor to be overloaded by up to 15% continuously without compromising reliability. With the lower losses and the reduced operating temperature of these high efficiency motors, bearing temperatures are also lower.

"Lower bearing temperature means that less grease is used, and the intervals between the re-greasing of bearings are longer," says Cristofolini.

Dust and water ingress is prevented by the unique WEG W3 Seal arrangement, which comes with an IP66 rating; this is the highest level of protection before entering the category of submersible motors. *"Taking into account that many mine sites often do not have extensive workshop facilities, the motors are designed for easy installation and maintenance, with solid feet and increased terminal box sizes that allow easy connections,"* he says.

Edson Cristofolini, Zest WEG Group African Business Development Executive.

He emphasises that it is worthwhile for mines to prioritise the total cost of ownership with high quality design and efficient performance in their choice of motors, with reduced maintenance and operational costs, as the capital cost makes up only about 2% of the motor's cost of operation over a 10 year life. According to Edson, the WEG Top Premium Efficiency IE3 motor range offers the lowest Total Cost of Ownership for the mining sector in Africa.

Signalling the end for Sandton traffic woes

The Sandton Central Management District (SCMD), in conjunction with Johannesburg Metropolitan Police Department (JMPD) and Traffic Freeflow, continue to work towards significant improvement to traffic signals and traffic flow in Africa's financial hub. According to the Johannesburg Road Agency (JRA), on average roughly 50 of Johannesburg's 2,135 intersections experience signal downtime each day. Ageing signal infrastructure and lack of secure electricity supply account for roughly 25% of faults reported daily.

However, proactively addressing the electricity supply to traffic signals, Sandton Central has already sponsored six uninterrupted power supply (UPS) units for traffic signals at key intersections in its well-managed precinct.

Elaine Jack, City Improvement District Manager for SCMD, says: *"We have invested in measures to ensure that key traffic signals in the district are always on. Also, we have partnered with the JRA on a number of key initiatives, including a traffic signal forum where we actively engage with both the JRA and Eskom technicians in order to reduce the time traffic signals are down. We work closely with JRA management and traffic engineers to relook traffic signal timings to ensure the best traffic flows too."*

Research aims to make artificial intelligence explain itself

Eight computer science professors in Oregon State University's College of Engineering have received a $6.5 million grant from the Defense Advanced Research Projects Agency to make artificial-intelligence-based systems like autonomous vehicles and robots more trustworthy.

The success of the deep neural networks branch of artificial intelligence has enabled significant advances in autonomous systems that can perceive, learn, decide and act on their own.

The problem is that the neural networks function as a black box. Instead of humans explicitly coding system behavior using traditional programming, in deep learning the computer program learns on its own from many examples. Potential dangers arise from depending on a system that not even the system developers fully understand.

The four-year grant from DARPA will support the development of a paradigm to look inside that black box, by getting the program to explain to humans how decisions were reached.

"Ultimately, we want these explanations to be very natural – translating these deep network decisions into sentences and visualizations," said Alan Fern, principal investigator for the grant and associate director of the College of Engineering's recently established Collaborative Robotics and Intelligent Systems Institute.

Developing such a system that communicates well with humans requires expertise in a number of research fields. In addition to having researchers in artificial intelligence and machine learning, the team includes experts in computer vision, human-computer interaction, natural language processing, and programming languages.

To begin developing the system, the researchers will use real-time strategy games, like StarCraft, to train artificial-intelligence "players" that will explain their decisions to humans. StarCraft is a staple of competitive electronic gaming.

Later stages of the project will move on to applications provided by DARPA that may include robotics and unmanned aerial vehicles.

Fern said the research is crucial to the advancement of autonomous and semi-autonomous intelligent systems.

"Nobody is going to use these emerging technologies for critical applications until we are able to build some level of trust, and having an explanation capability is one important way of building trust," he said.

The researchers from Oregon State were selected by DARPA for funding under the highly competitive Explainable Artificial Intelligence program. Other major universities chosen include Carnegie Mellon, Georgia Tech, Massachusetts Institute of Technology, Stanford, Texas and University of California, Berkeley.

Decreasing fibre installation costs

South Africa is currently experiencing phenomenal activity in the roll-out of fibre optic cables. While no-one disputes that the installation of fibre presents tremendous opportunities, the question being asked is how will this demanding initiative affect consumers' Internet connection costs?

With speeds of up to 100 Mbps, fibre will provide unsurpassed Internet speeds. It is also exceptionally reliable, highly secure and able to withstand testing weather conditions.

"However, this large-scale, challenging roll-out comes with a hefty price tag," cautions Bradley Hemphill, Managing Director of EES Live (Pty) Ltd. EES Live is a professional services company specialising in networks, data centres, security and building management systems.

If the country is to replace its 5 million copper cables with fibre optics, the cost will be roughly R60 billion, according to figures recently released by Finance24.

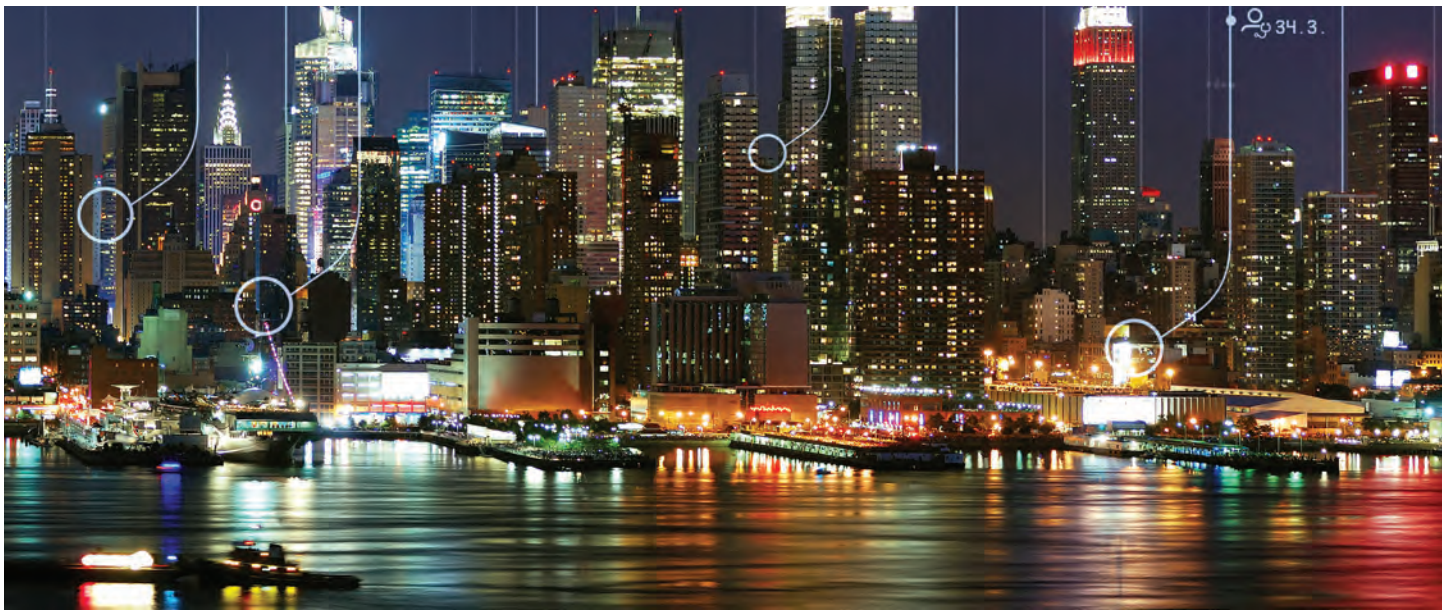
"It is vital that fibre network installation be carried out in the most efficient, yet cost-effective, manner possible," Hemphill continues.

Athi Ntisana, Engineer, EES Live, provides some insight into where and how performance can be optimised and at the same time costs contained. He states that a high cost component in the roll-out of fibre impacting on both CAPEX and OPEX is that of labour for high volume fibre connections.

"Operations, such as installing optical connections, that require skilled labour or long hours need to be managed," explains Ntisana. *"This is particularly important when moving from long distance networks to short distance distributing access networks, in which instance access networks' optical connections increase six times, resulting in high labour costs."*

It is therefore vital to select the most suitable optical connection. It appears that previously, connector technology usage was not based on the required application but on the readiness and availability of technology. Currently, access networks have three technologies to choose from, namely fusion splicing, mechanical splicing and factory pre-terminated. Fusion splicing has been largely used to date.

WATTSUP



Kone and hasan & partners Let The Elevators Do The Talking

KONE Taps IBM Watson to let the world hear machines in conversation.

Elevators have been given a voice to have conversations in real time, enabling people to hear machines talk.

Helsinki-based creative agency, hasan & partners, worked with KONE to connect selected elevators in different countries around the world.

The elevators have their operational information translated into English so they can converse continuously with KONE's cloud network using IBM's Watson IoT platform.

The elevators send data from sensors and controls about their day-to-day performance. That data is collected and processed, sent to the cloud, and given a voice. Ultimately if a fault is detected, a technician can be dispatched with the right parts to fix the problem, before anything occurs. The real-time chat can be heard at the Machine Conversations website, created by hasan & partners, where visitors can select an elevator and tune into the discussion with KONE Cloud.

Machine Conversations is a way to show people exactly what Internet-connected elevators would say, if they could be heard. It has been produced to support KONE's 24/7 Connected Services, which uses the IBM Watson IoT platform and other advanced technologies to bring intelligent services to elevators and escalators.

Predictability and responsiveness are vital for maintenance. In hot countries, an elevator may experience a rise in temperature, which the data could be misinterpreted as mechanical overheating.

Machine Conversations lets people hear how an elevator can tell the KONE Cloud: *"I'm running slightly hot, temperature at 28 degrees"*, with Watson's algorithms reviewing the data to decide whether action is required.

The humanized response might be along the lines of: *"you're five degrees above average, but it's a hot day outside, you're ok"*.

A typical elevator conversation might continue: *"Slightly off on landing at floor six"*; or *"Idle on floor zero. Perfect temperature at 22.6"; "Slightly elevated door noise"*. Replies from the KONE Cloud might be: *"I'm monitoring that, still normal. Keep going"*.

Tobias Wacker, creative director at hasan & partners, who came up with the idea said: *"Machine Conversations is creativity with a purpose, where we've leveraged Internet of Things technologies and the power of IBM Watson IoT to show how problems can be detected before they happen. We wanted to give the elevators and the cloud realistic voices, now we see and hear them in action it is an addictive experience and strangely compelling.*

Machine Conversations is an innovative way to promote our 24/7 Connected Services. Watson's cognitive capabilities will help us take elevator and escalator services to a new level identifying issues before they occur."

ACTOM Protection & Control signs on new protection and automation principals

ACTOM Protection & Control (P&C), a division of ACTOM (Pty) Ltd, has greatly extended its protection and automation product offerings for the local electricity distribution sector by bringing on board two reputable international companies as additional technology principals.

The newcomers are Arcteq of Finland, which produces and supplies protection equipment, and NovaTech located in the United States, which specialises in automation equipment. P&C signed an exclusive local distributorship agreement with Arcteq at the end of 2015 and with NovaTech early last year.

The business unit retains its longstanding partnerships with its existing protection and automation principals for the transmission and distribution markets.

"P&C is known for the level of service and support we provide in the market for all the products that we distribute. We are proud of our ability to understand the complex requirements of our market and ensure that our OEM partners appreciate them and work towards a satisfied customer," said Marius van Rensburg, P&C's Sales Manager.

"In the protection market the OEM often relies on strong local support to grow its offering. ACTOM P&C has been evaluated by both of our new partners, who are convinced of our capabilities in this regard."

Faisal Hoosen, P&C's General Manager, said: *"The new distributor arrangement enables us to provide a bigger choice of products to the local substation automation market. Both companies' products are innovative and state-of-the-art and the compatibility between their respective offerings is already proven. P&C, Arcteq and Novatech are already geared to providing ongoing service and support to the market."*

ACTOM Protection & Control personnel seen with an automation panel demonstrating Arcteq and NovaTech integration are (from left): Joe Steyn, Technical Specialist; Elizabeth Senatle, Product Manager, Protection Products & Systems; Andrew Perkin, Senior Design Engineer; and Herman Maré, Technical Specialist, Automation.

Referring to the technology agreement with Arcteq, he commented: *"We are very excited about our collaboration with Arcteq. Its in-house engineering capabilities as well as its close collaboration with First World universities has resulted in a product offering addressing the challenges of the modern electricity network.*

"We are pleased to be able to respond to end-user demand for a modern reliable protection platform which is flexible, user-friendly and forgoes legacy programming interfaces in favour of current future proof interface methods. Our clear advantage is that we are supported by a dynamic and highly experienced partner whose team has many years of experience in this market and is willing to further enhance its solutions to suit our customer requirements," Hoosen stated.

P&C is partnered by arc protection specialists Arc Protection Technologies in bringing Arcteq relays to the attention of the local market, as well as offering a range of additional services. *"Arc Protection Technologies is headed by Rodney Bristow, who is well known in the local market as a foremost authority in arc protection. They will be able to offer Arcteq relays directly to the market and will through ACTOM provide customers with additional services such as engineering, design and commissioning of protection systems,"* Hoosen added.

Arcteq's globally best known products are the AQ-100 stand-alone ARC protection range, a reliable fast-acting ARC fault-clearing device that is well-suited to local conditions in both medium- and low-voltage applications. Combined with Arcteq's AQ-1000 and AQ-2000 ARC-quenching devices, it introduces a new level of safety in the municipal, mining and industrial markets.

The 0.2S measurement accuracy and 3.2kHz sampling frequency makes the AQ-200 series products five to 10 times more accurate than any conventional protection device. For the first time a protection device can be used for billing level measurements or accurate station level energy sum calculations. The high sampling frequency of 3.2kHz, combined with a storing capacity of up to 100 fault records provides more information for fault analyses than any conventional protection device has ever been able to produce.

IN MEMORIAM

Victor Anton Raynal

It is with deep regret that we report that SAIEE Fellow, Victor Raynal passed away in March 2017.

1925 - 2017

Victor was born in Mozambique to become the third generation of a family that had engaged in the electricity supply industry in Southern Africa since 1898. His grandfather and father had worked for the Electricte De France Company in Mauritius and then Mozambique. When his father died of malaria when he was 8 years old, he was sent to boarding school at Marists Brothers in Johannesburg. He completed secondary school at the age of 16 and started a 5 year apprenticeship with the Johannesburg City Council (JCC).

Realising that he had potential, the JCC awarded Victor a scholarship which enabled him to do a degree in Electrical Engineering at the University of the Witwatersrand, where he graduated in 1950. He then had a professional training attachment with Ferranti in Oldham, England, which was at that time one of the largest electrical engineering distribution equipment manufacturers in the world. He recalled that Ferranti was developing the world's first commercially available computer and he considered whether he should develop his career along that path. However, Victor was very committed to using his engineering skills to develop the infrastructure in Africa. When he completed this professional attachment, he turned down lucrative job offers in the UK and other Commonwealth countries to resume working for the JCC.

While he was with Ferranti, he married Jean Stuttard, who worked as a paymistress in the company. Two years after Jean was tragically killed in a car accident in 1955, he married Margaret Bailey, also from Oldham; Basil de Ferranti, with whom he had become friends, attended this wedding.

Returning to continue his career in the JCC in 1955 he held various electrical engineering positions before being appointed as Assistant City Electrical Engineer (Distribution) in 1970.

This responsibility involved providing reticulation for a high population density area of about 500 square kilometres, which included Soweto. At that time it was the largest peri-urban conurbation in Africa, housing an estimated one million inhabitants, whose source of energy came from burning fossil fuels, the effluent from which blew over into the then Whites' only Johannesburg.

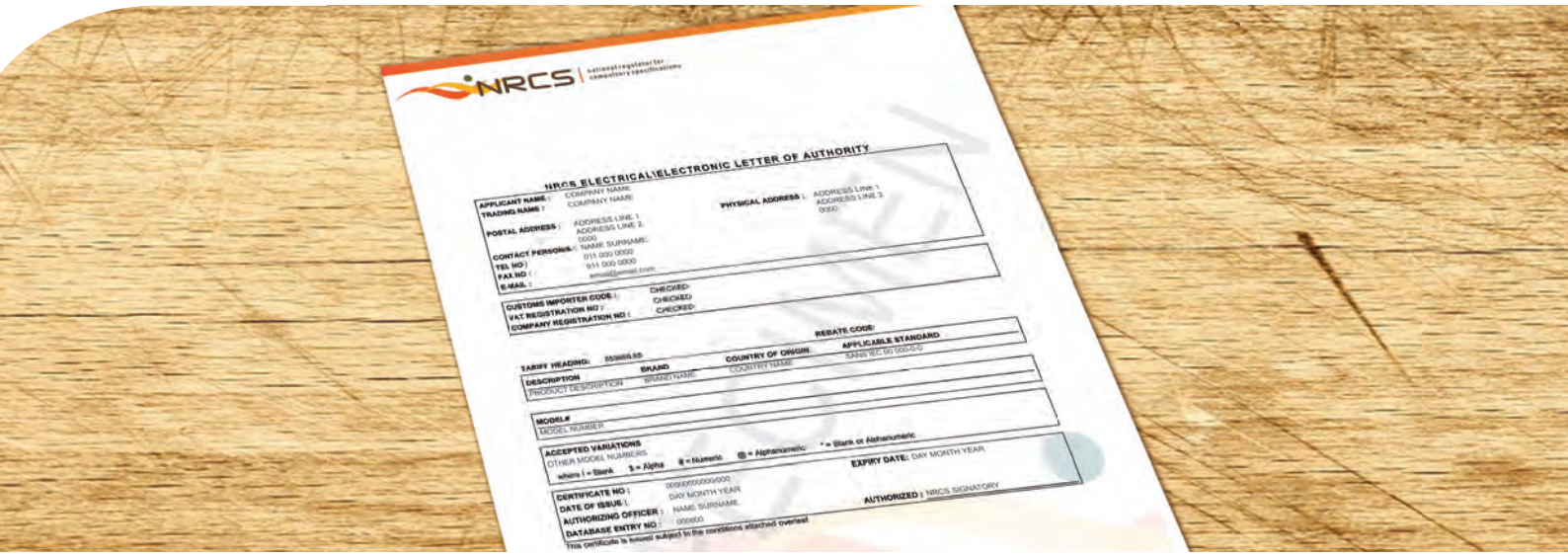
However, Victor saw the electrification of Soweto not only as a solution to regional air pollution, but also as a means to provide improved access to development opportunities for inhabitants. Victor developed ultra-high street lighting to provide vandal proof illumination for vast areas economically; although these may have looked like concentration camp illuminations for the endless rows of match box houses, Victor recalled the delight of residents who were not only able to get home more safely, but able to sit out on the pavements to read the newspaper and that children could do their home-work at no cost. He recalled many curious events when electricity first became available to a population who had no prior access in the late 20th century.

Victor achieved many academic and professional qualifications. He became a member of the Council of the South African and UK Royal Institutes of Electrical Engineers in 1970 and was appointed to the National Coordinating Commission (Niemand) setting standards for new residential townships. He authored three major papers for which he received awards entitled: "Cable Fault Location", "Insulating Oil in Relation to the Maintenance of Power Transformers" and "A Modern Approach to Reticulation of Residential Townships". He was awarded Fellowship of the SAIEE in 1976 and Fellowship of the UK IEE in 1979. In 1994 he received a 50 years membership award by the SAIEE.

Due to the frustration of non-progression in his career, Victor took early retirement from the JCC at the age of 55. He then worked for Croswell Engineers until he went into semi-retirement in 1989 in the Cape, but continued working on part-time projects until recently.

He leaves behind his widow Margaret; a daughter, a son and 8 grandchildren.

THIS IS NOT A DOCUMENT YOU CAN ALWAYS TRUST



A number of electrical products used by consumers and installed in buildings for use by occupants are subject to compulsory specifications in order to protect people. These requirements also have the effect of protecting assets.

The Letter of Authority (LOA), issued in good faith by the National Regulator for Compulsory Specifications (NRCS) on the strength of a product's test report by an accredited laboratory, is usually produced by distributors as proof of compliance with regulations and their safety requirements.

For one or more of the following reasons, and possibly others, this is not always the case:

1. Unscrupulous manufacturers and distributors submit specially-prepared, "***golden samples***", solely for the purpose of obtaining the LOA.
2. Manufacturers' ***quality-control*** processes may be, or may become, deficient.
3. Changes in a product's internal ***design***, or ***materials*** and ***components*** used, may render it non-compliant, whilst its appearance remains the same and compatible with its description on the LOA.
4. ***Errors and oversights*** by the testing laboratory, whose report is the basis for the LOA.
5. Fraudulent test reports and Letters of Authority produced by unscrupulous suppliers *

This reality and, amongst other reasons, the regulator's inability to conduct ***effective surveillance*** of the market to monitor compliance, results in the proliferation of sub-standard electrical products.

What to do? See the SAFEhouse website for a Guide to the Regulation of Electrical Products.

*Resellers of products may accept photocopies of LOAs as proof of compliance and not bother to validate them. Validation is difficult if not impossible.

SAFEhouse members have signed a code of conduct: Your assurance of commitment to offer only safe electrical products.

SAFEhouse membership is suppliers' assurance to customers of responsible behaviour and of customers' safety as a priority. SAFEhouse members regulate themselves. SAFEhouse is primarily a communications association that informs customers of safety requirements and occurrences of non-compliance with such requirements.

SAFE HOUSE™
Suppliers you can trust

As at 26/01/2017

The SAFEhouse Association is a non-profit, industry organisation committed to the fight against sub-standard, unsafe electrical products.

For more information contact:

Barry O'Leary: Tel: 011 396 8251 | Email: barry.oleary@safehousesa.co.za

Pierre Nothard: Tel: 011 396 8140 | Email: pierren@safehousesa.co.za

www.safehousesa.co.za

Solar just became safer with the PV GreenCard

Installing a rooftop solar photovoltaic (PV) system was for many years considered an expensive luxury but this is no longer the case. Drastic reductions in the cost of solar panels coupled with rising electricity tariffs and uncertainty of supply have made solar PV increasingly attractive to both residential and commercial energy users.

Although solar PV has become increasingly popular in the residential, commercial and industrial market segment over the last several years, there has until now there been no industry-wide, standardised PV licensing system or registration process. For this reason SAPVIA worked with industry to develop the PV GreenCard as a means to promote quality and safe Solar PV installations within the industry.

The PV GreenCard is a safety certification, a quality assurance standard, and training programme for solar PV installers. The most important aspect of the PV GreenCard is peace of mind that your Solar PV installation complies with industry and international best practice and installers meet minimum internationally bench-marked quality and safety standards.

Access to a database of qualified and verifiable solar PV installers via the PV GreenCard website is another way that we promote access to safe and reliable PV installations.

The quality and safety of a certified PV GreenCard installer is are assured via the specialized education and training provided to solar PV installers prior to them being certified and registered on the PV GreenCard database. This certification means that these installers are proficient and compliant with all of the relevant national and municipal electrical regulations.

On completion of an installation, a certified PV GreenCard installer will issue the client with both a digital and physical document that details all of the specifications of the solar PV system as well as a checklist that all of the required installation steps have been completed to the required standard. This document can in turn be used as proof of compliance for insurance, finance, and regulatory purposes.

"*At the moment we are seeing the residential, commercial, and industrial sector growing at about 5MW per month, and this will rise significantly as soon as the new small-scale embedded generation regulations are finalised. As a result we have shifted our focus more towards the development of the rooftop market over the last two years*" says SAPVIA Chairman, Davin Chown.

One of the reasons that PV is so popular in the residential space is that it is relatively inexpensive and quick to install. "*All you really need to put PV on your roof is a certificate of compliance for insurance purposes. There are professional installers who will install from 1kWp (4 panels) to over 1MW (over 4000 panels) on a roof,*" says Chown.

The PV GreenCard serves as a national standardized "as built report" that should be issued with every small-scale Solar PV installation.

With a PV GreenCard in your hand you have peace of mind that your solar PV installation complies with South Africn industry and international best practice.

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Our partners have been critical in the development of this quality initiative and we are grateful for the assistance of Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), BSW Solar, GreenCape, SARETEC. DGS Berlin has worked closely with us as development partners together with various government departments and SAPVIA members who have contributed throughout the development process.

The small-scale embedded generation revolution is already underway and as the industry body we have a crucial role to play in ensuring that installations standards are of a high quality and comply with municipal and national electrical regulations. WN

For more info, visit www.pvgreencard.co.za

I am terrible with names, and to everyone's delight, I called them by their country of origin:
From left: WiFi (He was always seeking signal wherever we went), China; Alejandra (Mexico); Me; Carina (Venezuela);
Ron Gerstenfeld, Ministry of Foreign Affairs; Korea; India; Brazil; Kenia and Ethiopia. 'Columbia' had already left, when this photo was taken.

The last supper

My Israel Visit March 2017

I had the privilege of being invited by the Israeli Embassy to attend the 5th Access Israel Convention 2017, in Tel Aviv, in March 2017. I was super-excited to have the opportunity of visiting a country on my bucket-list.

BY | MINX AVRABOS

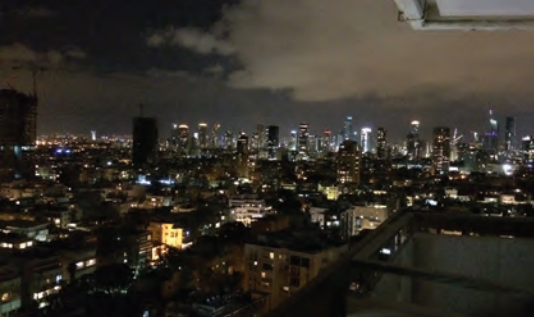
DAY 1

I had not realised that our Sunday is the Israelis' Monday, so I arrived in peak-hour traffic, and got to the hotel late to meet fellow journo's from across the world. I eventually managed to get hold of the tour guide, who organised a taxi for me to be able to meet up with them.

Our first stop was at the rehabilitation centre of the Sheba Hospital, where we met with various personnel who make a difference in the lives of people living with disability.

The Sheba Rehabilitation Hospital is Israel's national centre of rehabilitation. They offer long-term and life-long treatment, rehabilitation programs in areas such as orthopaedics, neurology, respiratory, psychiatry, geriatric and trauma. They have the national responsibility for the long-term treatment and care of the most difficult and complex cases in Israel, such as injured soldiers and terror victims.

The Sheba Hospital is also the pioneer in Rehabilitation Technologies. They are devoted to moving the rehabilitation field forward through



research, education and the development of life-saving therapies and technologies. They are globally renowned for their specialized laboratories and centres, where they develop innovative technologies in rehabilitation medicine, including Virtual Reality Training Facility, the Computerized Motion Analysis Laboratory, and the Isokinetic Laboratory.

The Virtual Reality Training Facility incorporates the latest advancements in computerized technology, sensors and video analysis to speed the rehabilitation of patients who have lost a leg, for example, through immersion in a fully reactive virtual and physical environment. The Computer Assisted Rehabilitation Environment employs a pioneering technology called Computer Assisted Rehabilitation Environment (CAREN). It is a breakthrough multi-sensory system for diagnostics, rehabilitation, evaluation and registration of human balance characteristics and movement control. The system enables the creation of a variety of experiences in a controlled and repeatable environment, by using several virtual reality principals.

DAY 2

Because this world is currently in the midst of the 4th Industrial Revolution, the **5th Access Convention** focussed on how to ensure the digital era is accessible for all. Access Israel also serves as an accelerator for start-ups. They have assisted 30 companies to launch products for people with disabilities since their inception. According to the latest Israel statistics, 2 billion people will need a device for disability by 2050.

Various speakers at the conference shared their insights into a range of technologies and best practices, specifically designed for organizations and business, who seek to hire and employ people with disabilities. This, as well as the technological means by which to serve the people with disabilities, including the elderly population.

James Thurston, Vice President, G3ICT, Global Strategy & Development discussed accessibility of Smart Cities – the technological aspect. This peaked my interest as we are busy organising the second SAIEE Smart Grid conference. The rapid worldwide growth in Smart Cities programs creates unprecedented opportunities for governments, citizens, and technology companies. This significant growth also risks deepening a substantial digital divide for persons with disabilities and the aging population. There is a compelling case for human rights and business issues for infusing accessibility into global Smart Cities programs. Governments who deploy accessible technology in their Smart Cities initiatives will have more innovative, equitable and impactful results across key program areas, including e.g. in education, healthcare, and transportation. Technology companies who include accessibility and inclusion as part of serving Smart Cities worldwide, will have an edge over competitors not doing so. They will be providing products and solutions that support rich, personalized, citizen-centric services serving a broader population, and are usable in a wider variety of environments.

The convention included a number of sessions, such as Smart Cities; App Accessibility, Media Document Accessibility, and Technological Presentations.

DAY 3

We were treated to a day-off by visiting the Dead Sea and Jerusalem. This was an experience I will never forget.

Bordering Israel, the West Bank and Jordan, is a Salt Lake whose banks are more than 400m below sea level, the lowest point on dry land. Its famously hypersaline water makes floating easy. In addition its mineral-rich black mud is used for therapeutic and cosmetic treatments at local area resorts. The surrounding desert offers many oases and historic sites.

We went to lunch at a restaurant, halfway between the Dead Sea and Jerusalem, called: "Last Chance" – aptly named when the owner decided that this is his last chance in making a living in a very remote area. Brilliant food and service!

Jerusalem was bursting with vehicles, colour and people. Everywhere we went, we were accosted by vendors selling their goods. I happened to buy two beautiful pashminas (scarves).

We took a walk to the Wailing Wall, where Tomer Zur, our tour guide, shared an insider's perspective of Jerusalem with us. The Western Wall, Wailing Wall or Kotel, is an ancient limestone wall in the Old City of Jerusalem. It is a relatively small segment of a far longer, ancient retaining wall, known also in its entirety as the "Western Wall". The Western Wall was built by King Herod in 20 BC, during his expansion of the

Temple enclosure, and is part of a retaining wall that enclosed the western part of Temple Mount. According to the Roman-Jewish historian Josephus, construction of the walls took 11 years, during which time it rained in Jerusalem only at night so as not to interfere with the workers' progress.

In 70 AD, the Romans destroyed Jerusalem and its Temple. During the Ottoman Period (beginning in the 16th century), the wall became the Jews' chief place of pilgrimage, where they came to lament the destruction of the Temple.

For centuries, the Western Wall was in a narrow alley just 4 metres wide that could accommodate only a few hundred densely packed worshipers. But in 1967, immediately after the Six Day War, Israelis levelled the neighbouring Arab district to create the Western Wall Plaza, which can accommodate tens of thousands of pilgrims. At the same time, the Israelis made the wall over 2 metres higher by digging down and exposing two more tiers of ashlars (squared stones) from the Temple Plaza's retaining wall that had been buried by accumulated debris for centuries.

After our visit to the Wailing Wall, we were treated to a Night Spectacular at the Tower of David. The show tells the story of Jerusalem. Cultures, religions rulers and legends magically appear on the ancient walls and among the archaeological remains of Jerusalem's citadel. The Night Spectacular is a celebration of sound, music and breath-taking images that envelope the viewer in a multi-sensory experience, and tells the complete story of Jerusalem from 3300 BC, to 1948. The Tower of David has been the iconic symbol of Jerusalem for generations.

DAY 4

We visited **Tikkun Olam Makers** (TOM), and met with Arnon Zamir, Chief Change Maker. TOM is a global movement of communities connecting makers, designers, developers and engineers with people with disabilities (aka - 'Need-Knowers'), to develop technological solutions for everyday challenges. Designs are free and available for any user to adapt for their needs! None of the products developed have been patented, and people are welcome to download the plans and improve on it. They believe that technology can improve the quality of live for others.

At **ReWalk Robotics Ltd,** we met with Ishai Potack, who is the R&D Manager. ReWalk is a wearable robotic exoskeleton that provides powered hip and knee motion, enabling individuals with spinal cord injury (SCI) to stand upright, walk, turn, as well as climbing and descending stairs. ReWalk is the first exoskeleton to receive FDA clearance for personal and rehabilitation use in the United States.

Our last visit for the day was to the Technion - **Israel institute of Technology, Robotics faculty**. American company, PTC, signed an agreement with the Technion to establish a centre for robotics and digital content. The agreement includes the option to expand the cooperation in the future to include the Technion institutions in the USA and China. The scope of the investment is 7 million dollars. The Technion sports 18 faculties, ± 600 staff members. They currently have 9000 undergraduates and 5000 master students.

DAY 5

I had the privilege of meeting with Gai Ben Dor, owner and founder of **180˚ Degrees**. It is an organization of running and walking groups that combines people with disabilities and volunteers who accompany them throughout the training sessions. They strongly believe that any person, no matter who they are, can improve their abilities and fulfil their potential through sporting activity. Gai Ben Dor is a senior speaker (TEDx), a marathon runner and a running coach.

At the **Wheelchair of Hope Foundation**, we met with Pablo Kaplan. Wheelchairs of Hope is an initiative to develop, design, manufacture and provide a wheelchairs to children in need of mobility. Their wheelchair is specifically designed for children, as they wish to empower education through mobility. Mobility from early childhood is a gateway to education. It is the basis for self-confidence and independence. By giving access to education, they create a new generation with better skills, confidence and hope.

We went off to visit the **Beit Issie Shapiro "Friendship Park"**. Beit Issie Shapiro (BIS) provides cutting-edge services to improve quality of life for people with disabilities, and to effect social change by breaking down the barriers preventing people with disabilities from full societal integration, assuring them the rights and opportunities for maximum growth and development.

Children with disabilities and special needs can often only dream about playing in a

playground. That dream has now become a reality for many fortunate children who come from all over Israel to 'Park Chaverim' or 'Friendship Park' in Ra'anana.

Israel's first accessible and inclusive playground gives children with disabilities an equal opportunity for recreation and fun. The playground brings children with different ability levels together to teach them how to play and have fun together, while raising community awareness about the importance of inclusion.

Our last visit was to Erica Koen, from **The Institute for the Advancement of Deaf Persons in Israel**, which was established in 1993, with the goal of providing previously unavailable services for the deaf and hard of hearing population, and of advancing and improving the existing field.

Today, they continue to provide professional, educational and rehabilitation services and programs for deaf and hard of hearing children, youth and adults in Israel. Deaf and hard of hearing people, who participate in the programs which they have developed and implemented, are empowered both to help others, and to live their own lives more independently and productively. It gives them full access to the types of services and opportunities already available to the hearing population. There are currently 750 000 deaf people living in Israel.

It was an absolute eye-opener to meet different people and be subjected to their difficulty in accessing places and people who we, the abled bodies able bodied, take for granted.

Thank you Embassy of Israel.

Putting the brakes on emissions

A new hydraulic lower cost and more efficient version of hybrid transmissions is set for launch to reshape the way South Africa seeks to do green transport in the country.

The MISER hydraulic hybrid system, developed by small business engineering firm Ducere Holdings, is a solution to regenerative braking and engine optimization for any size vehicle.

Andre Reyneke, Managing Director at Ducere Holdings says: *"While our country may not be quite ready to establish a full-blown electric vehicle, no-carbon emission market, such as the ones in other developed economies, we thought to innovate a product that achieves both fuel savings while reducing carbon emissions. Our product is ideal for new vehicle designs where the engine can be chosen, but they can also be retro-fitted to existing vehicles."*

"We have tested the MISER System on larger vehicles such as heavy duty trucks and the results are in: our fully automatic transmission surpasses all targets set by governments relating to fuel consumption and greenhouse gas emissions," adds Reyneke.

Simulation results, verified by international experts have demonstrated 70% fuel savings in city transit and 52% on highways, and correlates very closely to the emission reductions effected by the MISER System.

The real savings at our pilot project client shows us exceeding the targets set for part-MISER indicating that the above figures will be easily met once full-MISER is made available.

Norman Grant, Technical Director and Chief Design Engineer at Ducere Holdings is the brains behind this 'nifty little innovation' and believes that: *"What has worked to our advantage has been the utilization of advanced hydraulic technology, a sophisticated control system and mechanically simple gear and clutch system."*

Grant says that the product was tested and piloted at a local trucking company in Johannesburg and *"because it is so affordable, ROI is really quick, with pay-back possible in less than a year in certain drive cycles!"*

This engineering team has been working at their innovation for thirteen years, and thanks to the support of government and privately funded small business engines, are ready to present their product to market.

One such organization is the Climate Innovation Centre (CIC) South Africa which has incubated and supported Ducere Holdings during the pilot and commercialization process.

Head of the Green Economy Unit at The Innovation Hub, Dr Rethabile Melamu drives the CIC's efforts in supporting green entrepreneurs and sustainable innovation and

The Ducere Team
From left: Ryan Grant, Norman Grant, André Reyneke and Alan MacDonald.

is equally thrilled to be a part of Ducere Holdings' small business journey.

"The country's green economy is not dependent on one industry or sector, it requires the collective effort of a wide range of players who hone their skills and harness their efforts in a particular field. Transport, and particularly the financial and environmental cost of fossil-fuelled transport is one of many cogs in this wheel," remarked Dr Melamu.

The CIC South Africa is part of a global network of centres, established in partnership with the World Bank's InfoDev unit in 2015 and actively seeks out entrepreneurs who develop clean-tech solutions to local challenges.

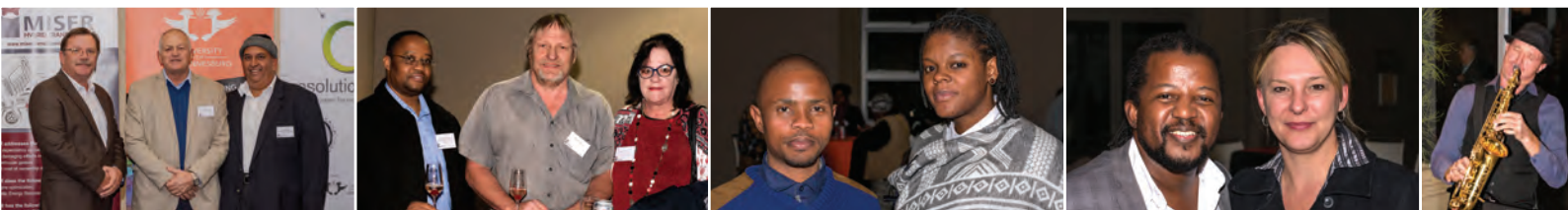
Dr Melamu says: *"The decision to offer Andre and his team strategic support services and to connect their business to funding opportunities was an easy one because the product is a direct response to the country's commitment to effectively green, not only our economy, but society as a whole."*

Last year (2016) was a 'coming of age' year for the MISER System as it received a number of accolades in the local innovation and green entrepreneurial landscape:

- WWF South Africa Climate Changer winners
- City of Joburg's GreenCity StartUp overall winners
- Cleantech Competition finalists
- Impact Amplifier / SSP awarded

Reyneke offers: *"We believe in the power of community, and this small business journey has not always been easy but the support we have received from a number of organisations in this fast-growing entrepreneurs eco-system has been incredible."*

The company has set its sights on skills transfer and training and creating job opportunities as the MISER System enters the market in July 2017 with its products available via Ducere Holdings' distribution network across the country.



Affordable hardware takes AfrikaBOT into township schools

BY | MINX AVRABOS

In October 2017 learners from schools in Alexandra, Diepsloot and Soweto will participate in an exciting robotics competition. With funds from the South African Institute of Electrical Engineers (SAIEE), support from the University of Johannesburg Faculty of Engineering and the Built Environment (FEBE), AfrikaBOT is the story of one person's crusade to reduce the cost of robotics and bring a quality pre-engineering experience to underprivileged teenagers.

After a two year stint in the USA working for a software company, Michael Ettershank got involved in youth robotics in South Africa. Wanting to offer something unique, he imported a Boe-Bot robotics kit from Parallax the USA. The desktop robot could be programmed with text, or easy graphics based software, to perform various tasks he felt might capture the imagination of teenagers.

There was just one problem – the imported robot was unaffordable for the majority of South Africans priced at about the cost of a monthly payment on a luxury German

sedan. For parents in South Africa who had not yet made it into the middle class, acquiring educational equipment like the American robotics kit was never going to be affordable.

"Coach" Michael, as he is known by the teenagers in his program, had an idea that if the teenagers could make the robots themselves then learning about robotics would be a lot more affordable. Also, by building the robot themselves there would be a lot more learning than by simply taking a robot out of a box which often happens in high school robotics.

So, he dusted off his old Antex soldering iron from when he was a teenager, and got busy.

Working nights and in the daytime hours Ettershank started presenting robotics workshops. A Pretoria property developer contacted Coach Michael because her son wanted to learn more about robotics, and this led to a series of classes where the teenagers built a clone of the American robot. It was quite crude, the body was made of LEGO blocks superglued together, but it worked. The learners acquired much knowledge not least of which was how to remove LEGO blocks glued to fingers. The wheels were peanut butter bottle lids.

AfrikaBOT into schools

continues from page 27

After testing the build-it-yourself robot on this comparatively wealthy group, in a partnership with the Department of Basic Education a series of Saturday morning workshops were held at Sci-Bono Discovery Centre where underprivileged teenagers built their own robots.

Leading Johannesburg private school St David's Marist Brothers, Inanda, where dedicated science teacher Mrs Glenda Dell wanted to start a robotics club, was the next pilot site to build the cloned robot. Then a flash grant by the Shuttleworth Foundation was used to train a group of underprivileged learners from Soweto at the University of Johannesburg TechnoLab in 2014.

Coach Michael gave up his regular job to join UJ TechnoLab full time in 2015, and with funds from the SAIEE he was able to launch AfrikaBOT 'the world's most affordable robotics competition'. The first competition was held at Zwartkops International Raceway in October 2016 alongside the annual Shell Eco-Marathon where high school learners and engineering undergraduates build and compete against each other to produce the most energy efficient vehicle.

Electronics parts distributor Mantech, a supplier to University of Johannesburg, sponsored the development of a high quality printed circuit board (PCB) with silkscreen so assembly of the electronics of the robot would be easier for inexperienced learners. With a quality printed circuit board the robot's electronics had become quite robust.

However, there was still a lot of cost in the robot chassis which had evolved from glued-together LEGO blocks to LEGO Technic beams held together with M3 nuts and bolts.

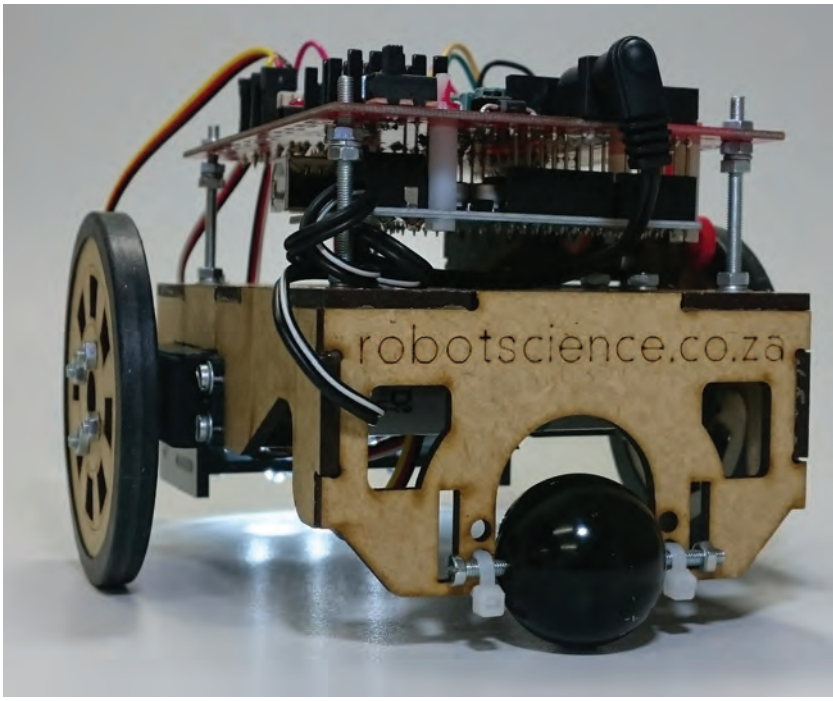
Finding an underused CNC milling machine in the engineering faculty at University of Johannesburg, Coach Michael teamed up with Dr Deon Sabatta, a lecturer at the University of Johannesburg, who designed a new body for the robot. Coach Michael figured out the CNC machine, and started mass producing parts for the desktop robot's new body from low cost rigid PVC sheeting.

Mobile power in the form of AA batteries for the now aptly named "AfrikaBOT" was costing TechnoLab a lot of money, but green laser torches with lithium batteries had become popular item at the China Mall on Main Reef road south of Johannesburg. Low cost replacement batteries and chargers had become readily available, so type 18650 rechargeable batteries became a reliable environmentally friendly source of power for the robot.

The Parallax OEM Basic Stamp 2 controller of the AfrikBOT, that can be programmed with graphical software or text code, remains one of the easiest platforms for teenagers to learn. The newer Arduino UNO had become available at much lower cost, with more processing power. The spectacular growth of the Arduino platform and a host of powerful new hardware options convinced The RobotScience Project to migrate to the Atmel 328 processor and C++ a computer language that is widely used in the automation industry.

The first AfrikaBOT competition, held in October 2016, was a big success with 140 teenagers organised into 49 teams. VIPs from the South African Institute of

Electrical Engineers, including Andre Hofmann and George Debbo, were present to meet and talk to learners from Soweto, Diepsloot and Alexandra High School about their robots.



What become apparent at AfrikBOT 2016 is participants needed more computers to program the robots. Having applied SAIEE funding to purchase 20 notebook computers for AfrikaBOT, this simply wasn't enough. The new Arduino-based robot goes a long way to solve the problem around access to computers with a programming app for smartphones and tablets called ArduinoDroid, written by Russian programmer and enthusiast Anton Smirnov. Many underprivileged learners are already equipped with low cost Android smartphones and tablets, so this will be an enabler for them going forward.

One problem with programming the Arduino AfrikaBOT from a cellphone is the small size of the screen, which could

AfrikaBOT into schools

continues from page 29

DESCRIPTION	MANTECH	COST PER	QTY	TOTAL
chassis		100	1	100
Arduino UNO		200	1	200
HQ breadboard		120	1	140
batteries		20	2	40
fasteners		50	1	50
arm servo		150	1	150
continuous rotation servos [motors]		150	2	300
			TOTAL	980

be frustrating for the learners, but smaller tablets have come down in price in recent years to around the R500 mark which is quite affordable.

The Arduino based AfrikaBOT now called "AfroDuinoBOT" consists of a new printed circuit board in the form of a standard Arduino shield. The Arduino UNO plugs on discretely underneath the shield. The AfroDuinoBOT PRO Robotics Prototyping Shield can also be used in non-robotics applications such for example as basic automation and solar power management. Mantech produced 500 double-sided, through-hole plated PCB for the AfroDuinoBOT the boards, being made available at R65 each to recover the cost of manufacture.

Six teachers from private school St David's Marist Brothers, Inanda, attended training at UJ TechnoLab towards the end of 2016 with a view to implementing a robotics curriculum in 2017. This is the first time building one's own robot from parts has been put into a South African high school's official teaching timetable.

An extremely comprehensive AfroDuinoBOT kit was released by Mantech to support the St Davids initiative, including everything from electronics sidecutters to quality soldering and all the other bits and pieces, but costs needed to be reduced to even more affordable levels. Considerable difficulties were also being encountered on the part of teachers and learners in the soldering of the PCB, so it was back to the drawing board.

Eliminating the soldering, which requires a costly soldering iron, and slightly increasing the size of the breadboard, and an attractive new, significantly cheaper robot resulted. The bare bones robot was named "AfrikaBOT 2" as the successor to the original, now long in the tooth AfrikaBOT, which is now called "AfrikabOT 1". Another advantage of the new AfrikaBOT 2 is because there is no soldering at the end of a season, the entire robot can be dismantled, the parts put back in the box, and it can be used again by the next learner the following year.

Learning how to solder, and building a printed circuit board will remain popular, and will continue to be offered to "advanced" students who have been through the basic training, but the AfrikaBOT 2 offers an easy low cost entry with a robot that has been tested, and is equal to any other in the competition maze.

Assuming a teenager already has a few hand tools, and a 18650 lithium type battery charger, it is not inconceivable that a teenager with a budget of just R1,000.00 can build a competitive AfrikaBOT robot ,which must surely be one of the world's most affordable robots…

TechnoLab will continue to support the original AfrikaBOT for the foreseeable future, as many teenagers have built these kits, but the newer robot does offer many advantages over the robot it replaces especially in terms of price, software and programming options.

In the design of the AfrikaBOT 2017 competition challenge, great care was taken to ensure that no advantage would accrue to a teenager depending on which robot they have. In other words, the playing field remains level, giving everyone a fair chance to win one of the coveted AfrikaBOT trophies.

In this way we are able to protect the investment many parents have already made in equipment, while continuing to drop the cost of getting involved in pre-engineering activities on a level playing field. wn

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Indoor Autonomous Mobile Robots: *A Maturity Framework*

BY | VLADYSLAV MUKHERJEE AND JOHN SANTAGATE

The market for robotics is growing rapidly, which is leading to the emergence, and subsequent maturity, of mobile service robots across a broad range of industries, applications, and use cases. Mobile service robots are gaining ground in manufacturing, logistics and distribution, hospitality, healthcare, and retail, among other areas. As the market for these robots evolves and these devices are used in new ways, it becomes important to look at what it means to be an autonomous mobile service robot and evaluate the differences relative to the terms "autonomous" and "mobile."

This paper defines the levels of maturity for these machines to help buyers better understand what separates these robots in terms of navigation, tools, and interfaces required to be truly autonomous as well as to help the manufacturers of these devices benchmark the capabilities of their own robots and plans for future development.

NOT ALL AUTONOMOUS MOBILE ROBOTS ARE CREATED EQUAL

Mobile automation devices have been in place in certain industries (e.g., manufacturing, warehousing, and distribution) for several decades.

Today, however, we are seeing an explosion in new applications as a result of the increasing levels of autonomy for indoor mobile robots given the rather recent and rapid increase in their capabilities and levels of maturity.

Please take to note that while mobile robots are deployed in various environments, this paper focuses exclusively on indoor mobile robots (we refer to the robots only as autonomous mobile robots in the remainder of the paper).

The evolution of this technology has brought up an interesting question around how to define the term "autonomous" relative to mobile robotics, or rather how to differentiate between different levels of autonomy. Different types of devices from different manufacturers (in some cases, even technology additions to more traditional vehicles such as forklifts) have introduced new ways in which an autonomous mobile robot will navigate and interact with its environment; there are also new and different tools and interfaces that enable automation.

Akin to the levels of autonomy for self-driving cars, where level 0 is entirely human operated and level 5 requires no driver, different levels of autonomy exist for mobile robots.

For this model, we are looking at the following elements as factors in determining the levels of autonomy for autonomous mobile robots:

- Navigation: The manner and capacity with which the autonomous mobile robot navigates its movement throughout a facility and the degree to which it is autonomous and can accommodate for the complexity and variability of the environment on its own
- Material handling: The capability to autonomously handle material (Material handling consists of two key characteristics: material transport and material transfer. Material transport relates to the robot's ability to move material throughout a facility; material transfer relates to the robot's ability to load and unload material.)

- Facility systems integration: The ability of the autonomous mobile robot to interact with, communicate with, and understand the physical environment in which it operates
- Machine-to-machine (M2M) communication: The ability of the robot to communicate multidirectionally with other machines and IT systems
- Unattended management: The degree to which the fleet can manage itself and the ability to handle unresolvable conditions externally

Autonomous mobile robots are in use in a variety of industries and types of facilities, with some robots better suited for certain uses than others.

Indeed, the requirements of a robot operating within a distribution warehouse will differ from those of a robot operating within a hospital, which is why it is important to develop a model to classify different robots and better align the capabilities to different job roles.

Figure 1 outlines the characteristics of mobile robots at each of the five defined levels of maturity.

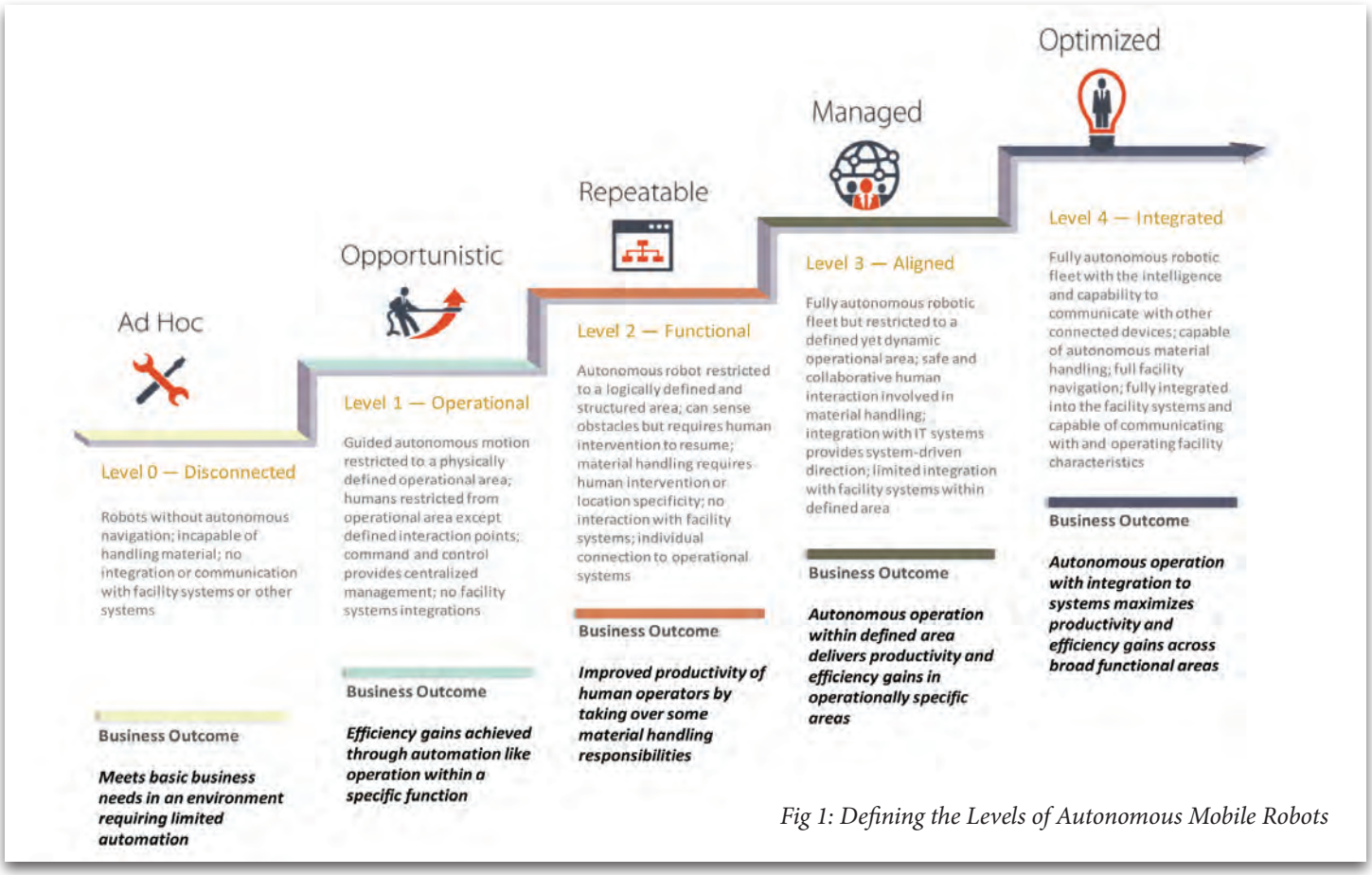

Fig 1: Defining the Levels of Autonomous Mobile Robots

Indoor Automation Robots

continues from page 33

Autonomous mobile robots come in a variety of sizes, shapes, and designs and have varying features and functionality. In addition to the purpose-built robot, there are automatic guided vehicles (AGVs) and even the capability to add sensors and computational navigation to vehicles such as forklifts to turn them from manually operated machines into autonomous vehicles. In developing the maturity model, we have identified the following five elements to create a reasonable comparison across the broad range of robots:

- Navigation: The way the robot determines how and where to move throughout a facility. In some instances, the robot is guided by beacons, markers, painted grids, or guidewires, and this would reflect a lower level of autonomy. In other instances, the robot is driven by a robust mixture of software and sensors to locate itself independently in the space for navigation. In addition to facility navigation, this element also considers the ability of the robot to detect and avoid obstacles within its path. Relative to obstacle avoidance, several approaches exist that evolve with the level of maturity. Some installations require "no go" space where only robots operate, some robots will detect an obstacle and stop operations until a human signals that it is safe to continue, and the most mature robots detect and identify the type of obstacle and appropriately respond.
- Material handling: The capability for robots to pick up and deliver material. This feature can take on several forms, such as the autonomous forklift that picks up and delivers pallets but is less sophisticated in other areas. Some robots can automatically pick up and drop off loads and place them in precise locations. Some robots have onboard bins that require a human to perform the pick-and-pack function; others are equipped with robotic arms and other electro-mechanical effectors that enable them to autonomously handle material.
- Facility systems integration: The capability for a robot to interact with the physical environment in which it operates. This includes the ability to autonomously open and close doors, call and operate elevators, and respond to building alarm conditions.
- M2M communication: The capability for individual robots to communicate multidirectionally with IT systems, other robots, and other equipment within a facility. More mature robots take direction from IT systems and communicate the status of jobs, location, and other information back to the IT systems. Multidirectional communication increases the level of automation. Additionally, this effort considers the ability of the robot to communicate with other robots while in operation to orchestrate the movement of material and tasks.
- Unattended management: The capability to run unattended and without human interaction. The most mature robots will be selected for the most complex environments, which introduces the risk of encountering unforeseen situations. In these instances, the most mature robots will have the ability to autonomously understand their situation, properly communicate their status, and allow external control and intervention to overcome any extreme issues.

This maturity model considers each of these five elements when defining the levels of autonomy. However, some devices may exhibit characteristics of higher maturity levels in one or more areas but remain in a lesser category of autonomy because of a lack of functionality in other areas. A robot's ranking must take into account the robot's capabilities across all criteria and may be only as mature as the lowest level the robot has achieved across any of the five criteria. For example, a robot that is at level 4 for navigation, material handling, M2M communication, and unattended management but is only at level 3 for facility systems integration is classified as a level 3 robot.

BENEFITS: THE VALUE OF AUTONOMOUS MOBILE ROBOTS

In the modern business environment, companies across verticals are looking at robotics to inject automation into their operations. Indeed, as the level of autonomy increases, so does the level of value received. Buyers of mobile robots should match the level of desired value with the level of autonomy when making a purchasing decision.

While the use of robotics in different verticals will vary depending upon application, there are several areas where the benefits span vertical and use case:

- Ability to augment human labor: Robotics is often associated with the replacement of human labor. However, this is not true in all cases; many organizations are looking at robots to augment human efforts. Mobile robots can and should be looked at to automate certain processes to free humans to work on value-adding activities that are not suitable for automation. For

example, a lot of time in manufacturing environments involves the movement of components and semifinished goods between manufacturing stations and the movement of finished goods to staging and packing locations. Often this movement is facilitated by a human, but robots can relieve the human operator of this function and allow that worker to focus on adding value in the manufacturing process. Additionally, the movement of material in the manufacturing environment can involve heavy loads, adding strain on the human operator. Using a robot to move such material can relieve the human operator and help reduce the risk of an injury. There is also the issue of employee turnover in the manufacturing environment, which is a significant cost to employers. Introducing robotics allows companies to better manage the impact of turnover because the robots will remain in place and can easily be added into the environment when necessary.

- Efficiency: A primary objective of any automation effort is delivering gains in efficiency that are not possible with a manual process. This is especially true when considering lean manufacturing, where any movement or transportation that is not adding value is considered waste. With modern levels of autonomy available, a significant amount of material handling is considered waste because it can be automated with the support of robotics. Additionally, the connected nature of autonomous mobile robots enables a business to capture movement data and thus run analytics and simulations that are not possible when the movement is conducted by human operators.
- Cost: Cost savings is a high priority in today's hypercompetitive market. Organizations that are better able to

Indoor Automation Robots

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reduce costs are creating a competitive advantage and positioning themselves for competitiveness into the future. Robots carry an up-front cost as well as some ongoing expense, but the ongoing expense is often a fraction of the cost of full-time employees, and the initial expense can be depreciated over time. Robots are also helping reduce the cost to serve by taking on functions that would otherwise be an ineffective use of a human, thus reducing the cost of service.

- Productivity: Increasing productivity is closely aligned with the idea of augmenting labor. Utilizing robots to do tasks that would otherwise go to humans frees humans to focus on more value-adding efforts. For example, instead of a nurse or another healthcare professional within a hospital delivering material to patients in their rooms, a robot can take on this task, which allows the hospital staff to focus on providing care to patients.
- Flexibility: Robots inject a layer of flexibility into the manufacturing operation. These devices not only are capable of working around the clock and handling a variety of material but also do not require the training and learning curve of humans when taking on a new task.

Overall, growth in the market for robots and the need for the market to attain higher levels of competitiveness through automation are helping manufacturing companies achieve significant value. From a maturity perspective, the higher a robot's level of autonomy, the greater the value. And the more a robot can do for itself, the more value it delivers to the business.

CONSIDERATIONS: GETTING IT RIGHT

The market for autonomous mobile robots is growing; at the same time, the devices and technology are evolving. Every organization will have a different perspective on the use of robotics within its operations. Despite the value associated with the use of autonomous mobile robots, there are certainly some risks and considerations to keep in mind when evaluating the applicability of robots within an operation.

The first step in evaluating the use of any autonomous mobile robot system involves determining what the business need is and developing the business case. Selecting the wrong robot with the wrong set of capabilities can be worse than not bringing in robots at all. Incorporating autonomous mobile robots into an operation requires a well-defined strategy and selection process to ensure that the decision does not result in a disruption to operations and a negative perception of the robots. The best scenario is one where there is little disruption in the integration process and the robots are user friendly and make the job of human operators more efficient.

Safety is a top priority, especially when introducing an autonomous mobile piece of equipment into an area where people are working. Tremendous advancements in sensors and mobility have helped bring to market robots that are safe and collaborative. The market for robots is shifting as we see the emergence of smart collaborative robots designed to work with people.

Cost must also be considered. An investment in robotics is just that, an investment. These devices must be purchased, leased, or delivered as a service. Organizations must ensure that the value to be delivered is worth the cost of deployment. Simply deploying robots does not deliver value; the value comes from appropriately selecting robots that meet the needs of the organization and help generate value in the form of efficiency and productivity.

Organizations must consider reliability when deciding on the deployment of robots into their operations. No piece of equipment is effective if it cannot be relied upon to efficiently, effectively, and consistently complete the tasks for which it is responsible. In IDC's maturity model for autonomous mobile robots, the higher levels of maturity relate to a device that is more reliable in its capacity to deliver results in a consistent manner.

TRENDS: A LOOK AT THE MARKET

The market for autonomous mobile robots is growing rapidly. Two factors driving this growth are the increasing acceptance for the use of robots and the improving capabilities and functionality being delivered by manufacturers of these devices. IDC forecasts that the worldwide market for commercial service robots will grow at a compound annual growth rate of more than 16% through 2020.

Autonomous mobile robots are one element considered in this segment of robotics, but we see this segment as one of the more rapidly growing markets. We also see a shift in the manufacturing industry where manufacturers are seeking to improve competitiveness and even third-party logistics companies are looking to expand the value-added services that they offer by including light manufacturing and

assembly. Manufacturers must consider robots as a means to deliver efficiency, productivity, and cost savings in their effort to grow and remain competitive. However, this is just one area of growth. These devices are increasingly being looked at within retail stores, ecommerce fulfillment centers, hospitals, and other locations to automate the movement of material throughout facilities.

CONCLUSION

Not all autonomous mobile robots are created equal. They differ in form, function, and technology. As the market increasingly accepts the use of robots, organizations must understand that there is an abundance of vendors out there with robots that span the differing levels identified in this maturity model.

Not all applications or environments will require a level 4 device; for some, only a level 4 device will do.

It is incumbent upon buyers to understand their needs and map those needs to the maturity model to identify what kind of device is most appropriate for their application. The bottom line is this: Robots are proliferating across all areas of business, and organizations that accept this and develop a comprehensive plan will be better equipped to successfully introduce robots into their operation. WN

AfrikaBOT Rules and Challenge for 2017

AfrikaBot is intended to be 'the world's most affordable robotics competition' to encourage young people to build their own robots from electronic parts, especially from disadvantaged communities.

- Entries into AfrikaBOT 2017 can be custom built robots made using Arduino, Parallax Basic Stamp 2, P1X8, P8X32, Raspberry Pi and other home built systems.
- An entry consists of a robot built by a team of one to four participants.
- All participant's names to appear on the entry form.
- Teams must register on the day at the competition, but it is a good idea to let UJ TechnoLab know in advance if you are planning to attend.
- Teams must pay for their own travel, accommodation, food and refreshments.
- Teams must bring their own notebook computers, with charged battery packs.
- Teams must have built and tested their robots before the event.
- Robots are required to perform a stop in which the robot must physically pick up the "fuel token" and carry it to the end of the maze.
- The winning robots in each age category will perform the tasks in the fastest average time, which will be the total of the times taken to navigate the maze, adjusted with any penalties incurred, divided by the number of times the robot navigates the maze.
- The robot that moves from start to finish, completes the "refuelling" stop and picks up the "fuel" token and does this faster than the other robots will be the winner in that category.
- Where a robot arrives at the finish without the fuel token that mission will score the maximum time.
- If time and the number of entries into AfrikaBOT 2017 permits, each robot will get three opportunities to travel through the competition maze.
- To enter AfrikaBot the robot must fit through the maze tunnel [120mm high x 260mm wide].
- Maximum size (diameter) of wheels permitted is 80mm.
- The organisers of the competition reserve the right to make any changes to the rules, without notifying contestants.

TROPHIES

The organisers will order high quality trophies* for the JUNIOR HIGH, SENIOR HIGH, UNDERGRADUATE and MAKER categories.

If you intend to enter in a category other than the above, or propose an entirely new category, provided you can demonstrate to the organisers that there will be more than five definite entries we can arrange for a trophy to be made.

**Trophies will only be awarded if there are more than five entries in a category.*

AWARDS CATEGORIES

Junior High School - Grade 8 & 9
Senior High School - Grade 10 - 12
Gap Year Inventors* - Post-matric students who intend entering higher education the following year.
Undergraduate - university students
Graduate - Graduates & postgrad student
Maker - All ages, including working folks, retired folks, engineers, people with a point to prove, etc.
INNOVATION PRIZE - innovative, cheap or recycled robot - decision of the judges will be final.

PERMITTED HARDWARE

P1X8, PARALLAX BASIC STAMP, ARDUINO, RASPBERRY Pi, MICROCHIP, INTEL, SMARTPHONES, PICAXE, ATMEL, etc.

PERMITTED LANGUAGES AND SOFTWARE INCLUDES, BUT IS NOT LIMITED TO

BASIC, C, C++, JAVA, PYTHON, SCRATCH, PBASIC, ROS, LOGO, WINDOWS, APPLE iOS, PROCESSING, UNIX, LINUX, ANDROID, etc. wn

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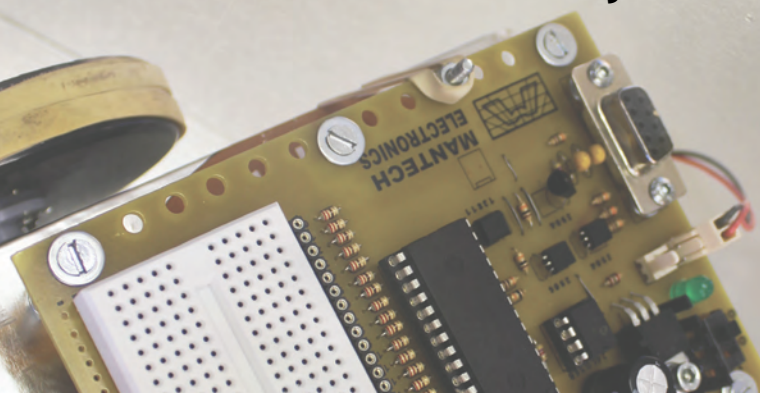

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Analysing Ribbon Bond in Silicon Solar Cells

The requirement for Ribbon Bond adhesion analysis has changed significantly over the past decade. In the Solar Photovoltaic manufacturing and applications, such data is processing is required to present more information about the quality of the finished product.

BY | MDUDUZI M. NTSHANGASE | PR ENG | MSAIEE

This paper reports on the application of statistical methods and algorithms using specialized software for the processing of Ribbon Bond adhesion data in 180° peel test. An application program was designed for the data analysis and the processed plants were evaluated with statistical results populated by the program. U. Eitner and Rendller studied the effects of peel test at different angles 45°, 90°,135° and 180° measure the forces, translate them to fracture energies and concluded that the mean increases by a factor of 0.6 fat the respective angle 45°, 90°, 135° and 180°.

THEORY AND APPLICATION

The physical and electrical quality of ribbon bonds to the silicon solar cell they are

mounted to is important to optimise yield, electrical efficiency and life expectancy. Peel tests are usually conducted to check the quality of the soldering, by measuring the force required to peel (break) them, and the observed failure mode is used to characterise quality.

Peel testing is complicated due to the fragility of the silicon solar cell. The silicon solar defects, such as micro cracks often occur during the soldering process.

The peeling is accomplished by applying an opposing force to the silicon solar cell ribbon. The peel force is often used to measure the strength of the bond in N/mm of ribbon width.

TESTING

During testing three principle failure modes may be observed. Bond failure - Low peel force/strength (none wet); URM (Under Ribbon Metallisation) failure – High peel force; and Silicone failure - Silicone damage during manufacture.

PROBLEM STATEMENT

In production, it is often required to test the quality of the finished product, in this case the strength. A data acquisition system was used to captured the strength data. However, the data from the System presents two problems:

- The system was not able to show the upper and lower limits on the graph and the feature of adhesion strength in N/mm of Ribbon width is was also not built into the software. The manufacturer had discontinued the software development of these computations on the software.
- The software is primarily suited to the Pharmaceutical Industry, and as such there was no pass or fail verdict command (built in computation function) in the software.
- The verdict command in the Manufacturer's Software, was inadequate for the Ribbon Peel Test processes as it was not qualitative. The graph from the data acquisition has a complex form. This required numerical analysis to be able to interpret and draw conclusions.
- Raw data can only be exported to Excel and where numerical analysis could be done. This task was not only time consuming in the production environment, but inconclusive as well. It need to be automated.

Analysing Ribbon Bond

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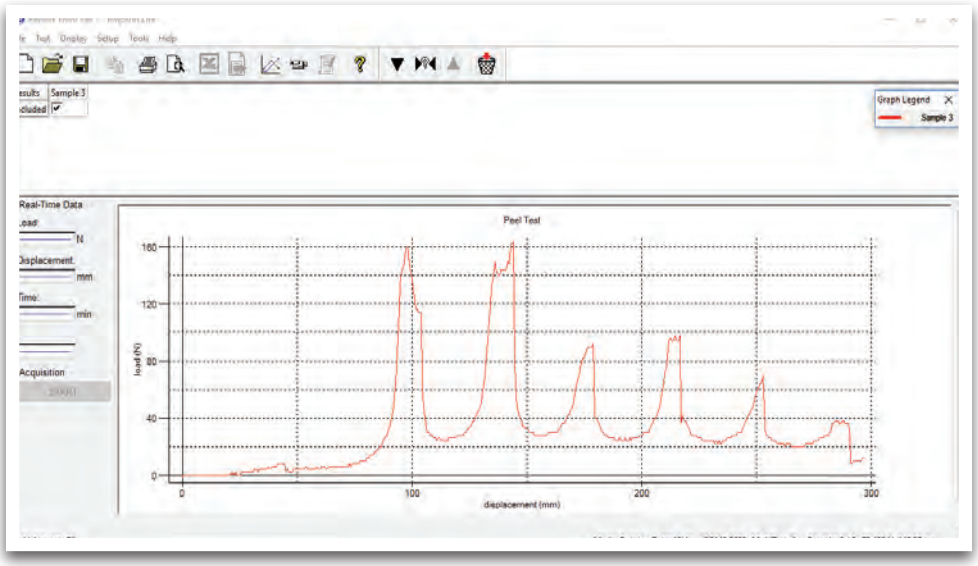

Figure 1: Emperor Lite™ Data Acquisition Software

Figure 2: Peel Test Application Program

SOLUTION

A solution to the above problem was conceptualized, synthesized and implemented:

- Raw data from the test is stored in an Excel File.
- An application program (see Fig-1) was designed to process the data, showing the limits, Compute statistical result for each Section of the analysed sample. The mean adhesion strength N/mm ribbon width for each pad on the solar cell and the standard deviation is developed.
- The solution offers an automated data processing tool that suited the solar manufacturing production process and environment. The program allows for results data archiving in a database to large volume of data for further processing, historical trending for further studies.

CONCLUSION

- A study was conducted on the strength and the quality of the products. From the study the following conclusions can be drawn
- A Software program was designed in Microsoft Visual Studios 2015 in C#.
- The program is an automated solution which provides statistical analysis data results.
- From the improved statistical data, it is easier to interpret the data statistically, and address quality related issues, and then come up with meaningful conclusions.

FUTURE WORK

- Improve the Software program, to access the data directly from the Instrument using a serial RS232 communication, and thus enabling real time processing.
- The point mentioned above would increase the data processing speed significantly, enabling an increased productivity in a fast-paced manufacturing environment.

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The SAIEE is aware that professionals registered with the Engineering Council of SA (ECSA) are hard pressed to acquire the required CPD credits necessary to re-register every 5 years with ECSA.

We are also aware of the high costs associated with acquiring these CDP credits. There is the cost of the course, the time and travel costs and this can be very high - particularly for those professionals in rural or out of town locations.

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The deal is you read the designated articles in the **watt**now magazine and answer 10 questions, that if correctly answered, qualify you to claim CPD credits. Every issue of **watt**now entitles you to acquire a nominal 0.1 credit and over 12 months this amounts to a nominal 1.2 CPD credits per annum. On completion of your annual subscription, you receive a letter from SAIEE confirming the amount of CPD credits you earned.

This benefit is not only open to members of SAIEE, who enjoy a significant reduction in the cost of this scheme, but also to non-members at a higher cost. This service is available on-line and so is the designated CPD articles that allow you to answer the questions and, if correct, you acquire the CPD credits.

Details of the scheme are as follows:

- Apply to the SAIEE On-line CPD Scheme by contacting Douglas Millar;
- After you have applied online, you will receive an invoice - if you are a SAIEE Member, you will pay R1,200.00 per year. Non-members will pa y R2,400.00 per year.
- Once your payment has been received, you will receive a username & password to complete the online program;
- Answer the online questionnaire correctly (to prove you have read and digested the content);
- The online system records your score and tallies up your accumulated credits;
- After 12 months, you receive a letter awarding you your CPD credits and an invoice to continue for another year. Receipt of payment signifies your membership of the scheme.

In addition to the above credits accumulated in Category 1 of the ECSA policy, if you are a member of SAIEE in good standing, you automatically may claim one CPD credit for being a member – in category 2 of the ECSA policy.

Thus, with this scheme, you can acquire 2 CPD credits per year each in Category 1 and 2 of the ECSA policy.

This is a very affordable way for members of SAIEE and non-members to meet the requirements for re-registration of your professional status.

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Any questions or concerns please contact Douglas Millar.
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SAIEE Education and Bursary Fund

'Nurturing tomorrows technological leaders'

Quality tertiary education costs are increasing and many students show excellent academic potential but are unable to finance their education.

The SAIEE would like to position itself in such a way that it is able to support students that are academically strong yet in financial need. Supporting these financially needy students, would significantly impact on their lives and enable them to focus on their studies.

It is for this reason that the SAIEE has established an 'Education and Bursary Fund' and currently supports 16 students studying Electrical, Electronic or Computer Engineering at South African Universities or Universities of Technology.

In order to increase its support and impact on a greater number of deserving students, we calls upon our members to make contributions to this fund. This would enable South Africa to develop high quality Electrical Engineers and Technicians that would be able to make a sustained contribution to the economic development of the country.

Our reputation as a well-managed institution assures our donors that we apply prudent financial management to their donations. We guarantee that your gift will be used as intended!

WAYS TO GIVE

- Monthly donation
- Once off donation
- EFT payment
- Credit card payment
- Donation

Whatever the level of your giving – from a few Rands per year to thousands or more – your support is valued by the SAIEE and the deserving beneficiaries of your generosity. An annual progress report is produced on all beneficiaries.

HOW WOULD THE FUNDS BE AWARDED?

Each year there is a call for students studying Electrical, Electronic or Computer Engineering to apply for financial support.

An evaluation committee, comprising members of the SAIEE Council, evaluate all the applications and the individual students are interviewed.

Based on their academic results and financial need, the applicants are ranked and awarded accordingly.

Each awardee signs a contract with the SAIEE with terms and conditions. wn

Members wishing to contribute to the SAIEE Bursary fund should contact Dudu Madondo and request the necessary application form - dudum@saiee.org.za.

DO YOU NEED FINANCING TO COMMENCE OR CONTINUE YOUR STUDIES?

Now is the time to apply for a SAIEE Bursary* for the 2018 Academic year.

SAIEE Bursaries are for studies in Electrical, Electronic and Computer Engineering only.

Matriculants who have passed Grade 10, as well as students who intend to pass Grade 12 this year are eligible.

Students at tertiary institutions who have completed their 1st, 2nd and 3rd year are also eligible.

Applications from the Dependants/Guardians of members of the SAIEE will receive preference.

Application forms are available from:
The Secretary, Bursary Administration
Dudu Madondo
Tel: 011 487 9045 • Fax: 011 487 3002
Email: dudum@saiee.org.za
www. saiee.org.za

APPLICATIONS CLOSE 31 OCTOBER

** Bursaries are for South African Citizens only.*

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SAIEE

Earn CPD Credits

The Cassin-Huygens mission to Saturn, its rings and moons is rapidly drawing to a close after two decades of hugely successful and flawless operation.

COMPILED BY | DUDLEY BASSON

The mission is named after Italian scientist Giovanni Domenico Cassini (1625-1712) and Dutch scientist Christiaan Huygens (1629-1695).

GIOVANNI CASSINI

Cassini is known for his work in astronomy and engineering. He discovered four of the moons of Saturn and also a division in the rings, which has become known as the Cassini division. He is also known for the project of creating the first topographic map of France.

Cassini started his career in 1648 with a position at the observatory of Panzano near Bologna. He was able to complete his education under the scientists Riccioli and Grimaldi. In 1650 the senate of Bologna appointed him to the principal chair of astronomy at the University of Bologna.

Giovanni Domenico Cassini 1625-1712

The Magnificent Cassini-Huygens Mission

Cassini persuaded the church officials of San Petronio Basilica to move the pinhole gnomon to project the Sun's image 66,8 metres away. This enabled him to measure changes in diameter of the Sun's image over the year confirming Kepler's 1609 heliocentric theory of the Earth moving around the Sun in an elliptical orbit.

Cassini left Bologna in 1669 to help Colbert set up the Paris Observatory financed by a grant from "The Sun King" Louis XIV. He served as astronomer/astrologer to the King but preferred to spend most of his time on astronomy. He had spent much of his time in his youth studying astrology.
Cassini's method of determining longitude was used to measure the size of France accurately for the first time. He used the method suggested by Galileo, using eclipses of the Mars Galilean moons as a clock.

He was granted French citizenship in 1673, becoming known as Jean-Dominique Cassini in France.

Cassini observed and published the surface markings on Mars (earlier seen by Huygens), determined the rotation periods of Mars and Jupiter, and discovered four satellites of Saturn: Iapetus and Rhea in 1671 and 1672, and Tethys and Dione in 1684.

He discovered the Cassini Division in the rings of Saturn in1675 and shares with Robert Hooke credit for the discovery of the Great Red Spot on Jupiter.

Cassini had a brilliant reputation for working on engineering and structural works.

While in Italy he was employed by Pope Clement IX in regard to fortifications, river management, and flooding of the Po River. The Pope invited Cassini to take Holy Orders to work with him permanently but Cassini declined, preferring to work full-time on astronomy.

CHRISTIAAN HUYGENS

Christiaan Huygens was born in The Hague to a prominent family. His father Constantin had studied natural philosophy and was a diplomat. It was through him that Christiaan was able to gain access to top scientific circles of the times. Constantin had many contacts in England and corresponded regularly with Mersenne and was a friend of Descartes.

Christiaan was tutored at home by private teachers up to age 16 and also learned to

Cassini-Huygens Mission

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Christiaan Huygens
1629 - 1695

play the lute. Descartes was an occasional visitor at the Huygens' home and took an interest in Christiaan's mathematical progress. He studied law and mathematics at the University of Leiden from 1645 to 1647.

He published his first mathematical papers "Cyclometriae" in 1651 and "De Circuli Magnitudine Inventa" 1654.

In 1654 he devised a new and better way of grinding and polishing lenses. Using one of his own lenses, Huygens detected, in 1655, the first moon of Saturn.

In 1656 Huygens patented the first pendulum clock - which he developed as he required accurate timekeeping for his astronomical work. Galileo had, by observing the swing of a chandelier in Pisa Cathedral, concluded that the period of a pendulum swing depends only on the length of the pendulum and not on the mass or amplitude of swing. This is not strictly accurate as a swing period independent of amplitude would require a cycloidal path and not the circular path of a pendulum. This does not matter for a longcase clock as the pendulum will not normally swing with varying amplitudes. This is known as the tautochrone problem. This closely related to the brachistochrone problem which also requires a cycloidal path.

Huygens believed that a large pendulum swing would be more useful at sea and developed a cycloidal pendulum with this in mind. He described the theory of pendulum swings in his work: *"Horologium Oscillatorium sive de motu pendulorum"* (1673).

He also derived the law of centrifugal force for uniform circular motion. As a result of this Huygens, Hooke, Halley and Wren formulated the inverse-square law of gravitational attraction.

In 1661 Huygens visited London, particularly to find out more about the newly forming Royal Society meeting at that time in Gresham College. He showed his telescopes to the English scientists which proved superior to those in use in England. The Duke and Duchess of York came to observe the Moon and Saturn through Huygens' telescope. Huygens was elected to the Royal Society of London in 1663.

In 1672 Huygens and Leibniz met in Paris and thereafter Leibniz was a frequent visitor to the Académie. In fact Leibniz owes much to Huygens from whom he learnt much of his mathematics. In this same year Huygens learnt of Newton's work on the telescope and on light.

In England Huygens met Newton, Boyle and others in the Royal Society. It is not known what discussions went on between Huygens and Newton but we do know that Huygens had a great admiration for Newton, but at the same time did not believe the theory of universal gravitation, of which he said: "appears to me absurd".

In some sense of course Huygens was right, how can one believe that two distant masses attract one another when there is nothing between them. Nothing in Newton's theory explains how one mass can possibly even know the other mass is there. The General Theory of Relativity was still more than two centuries away.

In the final years of his life Huygens composed one of the earliest discussions of extra-terrestrial life, published after his death as the Cosmotheoros (1698). He continued to work on improving lenses and on a spring regulated clock and on new pendulum clocks. Huygens described the musical 31-tone equal temperament in *"Lettre touchant le cycle harmonique"*. This has led indirectly to a tradition of 31-tone music in the Netherlands in the 20th century.

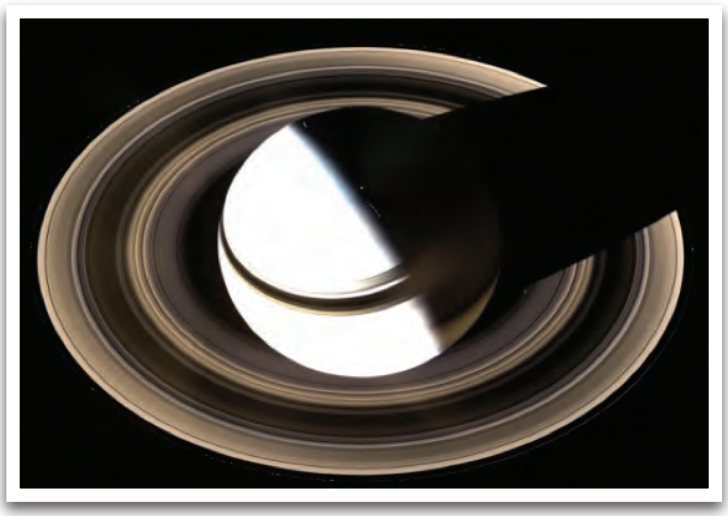
The 31-tone scale (31-ET) divides the musical octave into 31 even tempered steps. The step frequencies progress by the 31st root of 2 (1,022611). After reading Huygens' work, physicist, music theorist and composer Adrian Fokker led a revival of interest in this system of tuning which led to a number of compositions. He also built a 31-tone even tempered organ which was installed in Tyler's Museum in Haarlem in 1951.

An eclipse of the Sun by Saturn as seen by Cassini. The disc of Saturn is in darkness except for light reflected from some of the inner rings. The near sides of the rings in front of the planet are in darkness and invisible. The rings are illuminated from behind by the Sun. The second image shows how the shadow fell at the time of the Cassini eclipse.

Saturn is the sixth planet from the Sun and the second largest after Jupiter. Its rings make it the most easily recognised astronomical object. In any logo or graphic depiction of astronomical matters there will invariably be an image of Saturn and its rings. It has an average distance from the Sun of nearly ten astronomical units: 1,5145 x 10^9 km at aphelion and 1,3525 x 10^9 km at perihelion.

The orbital period is 29,45 Earth years with an orbital speed of 9,68 km/s. The planet has an equatorial radius of 60 268 km and a polar radius of 54 364 km. The planet consists of 75% hydrogen and 25% helium. It is thought that the planet has a small rocky core which was the seed for the original accumulation of the planet.

The core is surrounded by a layer of liquid metallic hydrogen and outer layers of liquid molecular hydrogen and helium. It is not possible to produce liquid metallic hydrogen on Earth due to the immense pressure required. The hydrogen gas that makes up most of the atmosphere slowly changes to liquid with depth as the pressure increases. Below the liquid hydrogen rests the heavier liquid helium. The temperature at the centre is thought to be 12 000 K. Saturn has an internal heat source as it radiates 2,5 times as much heat as it receives from the Sun. It is thought that the internal heat of giant planets is caused by the planet collapsing in on itself in the process of planet formation. The heat produced causing the unusual and violent motions in the atmosphere.



The rings, which extend from 6 630 km to 120 700 km above Saturn's equator were objects of much confusion to Galileo. Huygens, using a superior telescope to that of Galileo, was the first astronomer to observe that Saturn was surrounded by thin flat rings. The rings are thin indeed compared to their immense size; only about 20 metres thick and consisting mostly of water ice fragments. On a scale model of Saturn of one metre diameter, the rings would be about 0,3 micron thick. (Ordinary copier paper has a thickness of 100 microns.) The nature of the rings remained a puzzle until James Clerk Maxwell proved mathematically (60 pages) that the rings must consist of small particles orbiting independently.

Cassini-Huygens Mission

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When Astronomer Royal, Sir George Biddell Airy read it, he commented: *"It is one of the most remarkable applications of mathematics to physics that I have ever seen."* Mathematician Laplace also dealt with this problem in his famous book 'Mecanique Celeste'. This book was translated into English by the famous Scottish scientist and mathematician Mary Somerville.

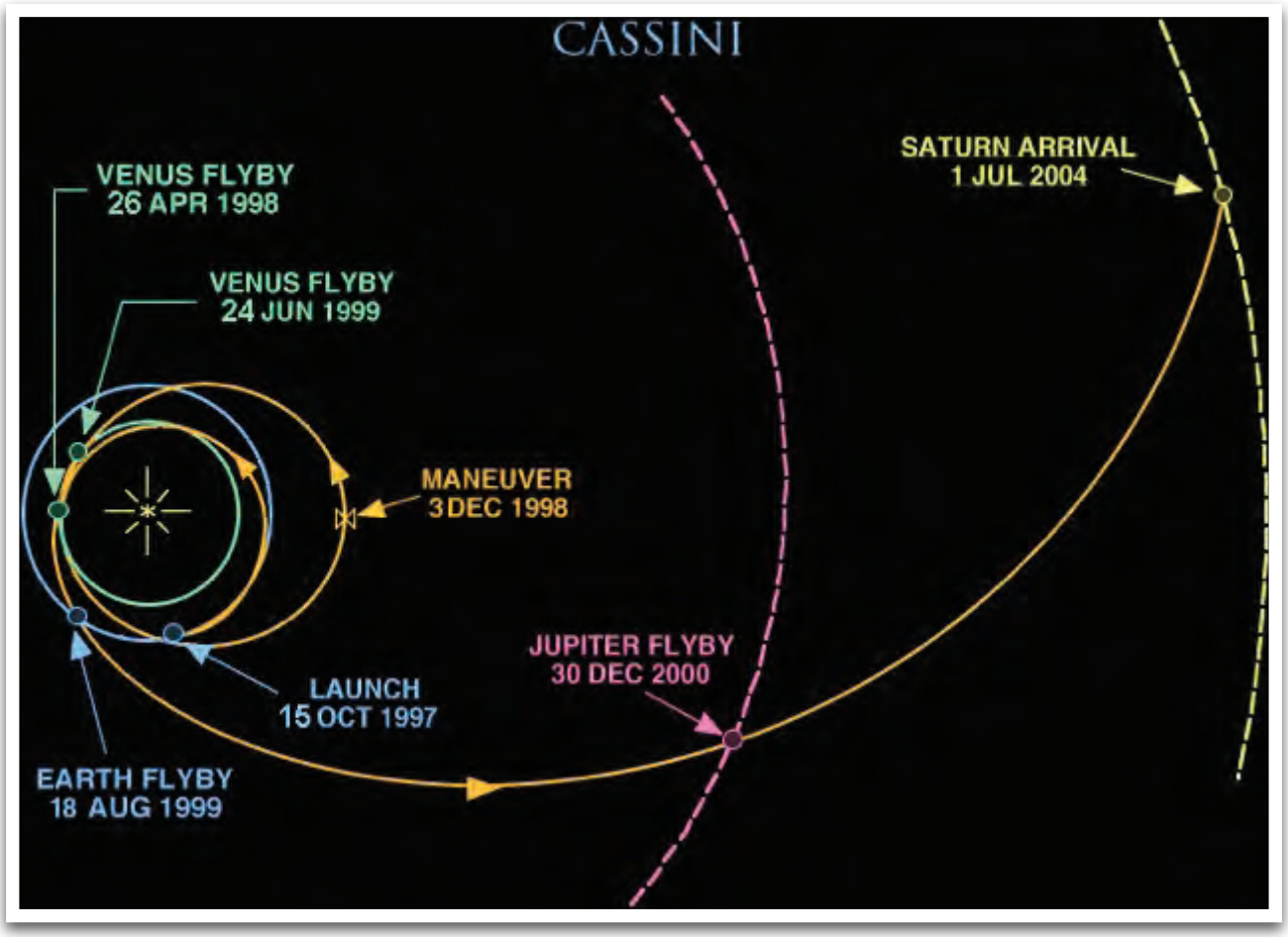
The Cassini-Huygens mission to Saturn, a joint flagship-class venture by NASA (National Aeronautics and Space Administration), ESA (European Space Agency) and ASI (Agenzia Spaziale Italiana) was launched from Cape Canaveral on 15 October 1997. This is a combined orbiter and probe mission, the Cassini Orbiter being supplied by NASA and the Huygens Probe by ESA.

ASI developed the high gain antenna with the incorporation of a low gain antenna to ensure communications with the Earth for the duration of the mission, as well as the VIMS spectrometer, the radio-science subsystem (RSIS) and the radar which also uses the high-gain antenna.

ASI has also developed for the Huygens Probe, the HASI instrument, which measured the physical properties of Titan's atmosphere and surface.

Due to the vast distance of Saturn from the Sun, it was not possible to use solar panels to power the satellite. Power was provided by three RTGs (Radioisotope Thermoelectric Generators) fuelled by 32,8 kg of plutonium-238.

This gave rise to controversy at the time due to the risk of radioactive contamination in the event of a failed launch. The fears were however unfounded as the risk of radiation from the plutonium would have been negligible due to the precautions taken. By the end of mission the plutonium dioxide pellets were still glowing red hot and capable of producing 600 W of power.



Cassini's complex seven year gravity assisted route from Earth to Saturn.

Future missions could possibly be powered by Stirling engines, as these can operate far more efficiently than thermocouples.

The launch mass was a massive 5574 kg, of which 3132 kg was due to the monomethyl hydrazine and nitrogen tetroxide fuels for the bi-propellant thrusters.

A phenomenal 'must see' timeline slide show of the entire mission can be seen on: www.saturn.jpl.nasa.gov.

The complex route of Cassini to Saturn involved two gravity assist flybys of Venus on 26 April 1998 and 24 June 1999. It then took a gravity assist flyby of the Earth on 18 August 1999, also making a close approach to the Moon. It next performed a flyby of asteroid 2685 Masursky on 23 June 2000, also taking images which indicated a diameter of 15 to 20 km.

It reached Jupiter in December 2000 taking 26 000 detailed high quality colour images during the flyby and also made several discoveries concerning storms in the atmosphere.

On 10 October 2003, the Cassini science team announced the excellent results of the occultation experiment using radio waves from the craft, which passed close by the Sun, to provide additional proof of Einstein's Theory of General Relativity.

Cassini arrived at Saturn's moon, Phoebe in June 2004 making close up studies during the flyby. It eventually, after a seven year voyage, arrived at Saturn in July 2004 passing through the gap between the F- and G-rings and going into orbit around the planet. Only a day after arrival, Cassini performed the first of 24 planned flybys of the moon, Titan, taking radar and optical images as well as topographical data.

Cassini-Huygens in the pre-launch clean room

CASSINI INSTRUMENTS

To gather as much science as possible during its historic mission to the Saturnian system, the Cassini-Huygens spacecraft is equipped with 18 instruments, 12 on the Cassini orbiter and six on the Huygens probe.

Many of these sophisticated instruments are capable of multiple functions, and the data that they gather are studied by scientists worldwide.

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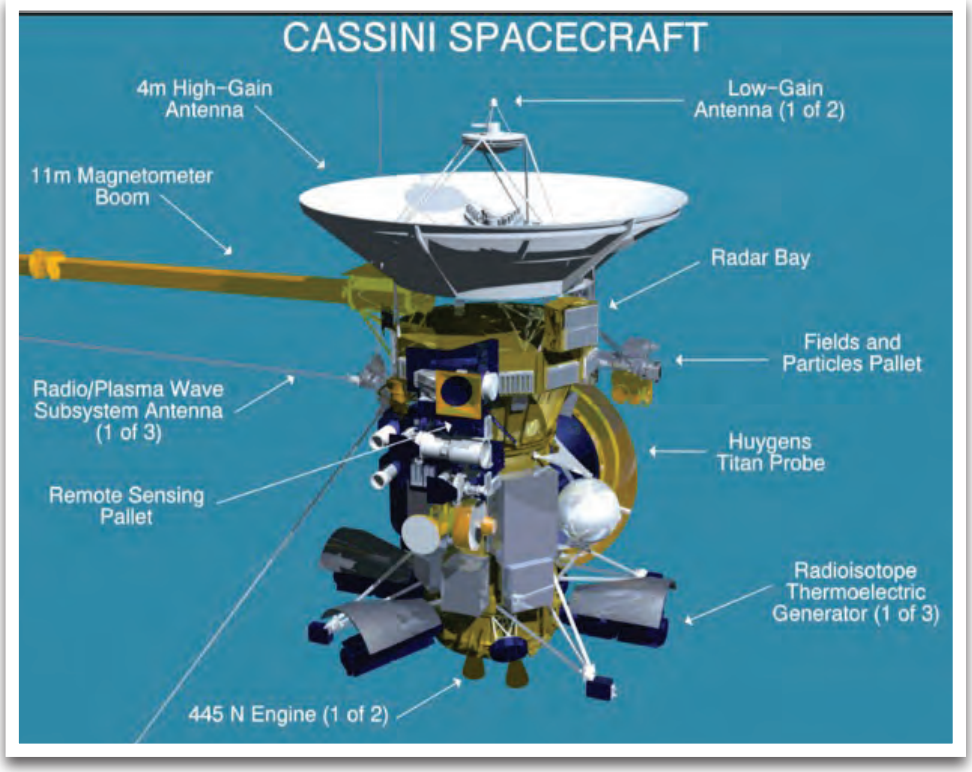
- Cassini Plasma Spectrometer (CAPS) explores plasma (highly ionised gas) within and near Saturn's magnetic field.
- Cosmic Dust Analyser (CDA) studies ice and dust grains in and near the Saturn system.
- Composite Infrared Spectrometer (CIRS) measures infrared energy from the surfaces, atmospheres and rings of Saturn and its moons to study their temperature and compositions.
- Ion and Neutral Mass Spectrometer (INMS) examines neutral and charged particles near Titan, Saturn and moons to learn more about their extended atmospheres and ionospheres.
- Imaging Science Subsystem (ISS) takes pictures in visible, near-ultraviolet and near-infrared light.
- Dual-Technique Magnetometer (MAG) studies Saturn's magnetic field and its interactions with the solar wind, the rings and the moons of Saturn.
- Magnetospheric Imaging Instrument (MIMI) images Saturn's magnetosphere and measures interactions between the magnetosphere and the solar wind, a flow of ionised gases streaming out from the Sun..
- Cassini Radar (RADAR) maps surface of Titan using radar imager to pierce veil of haze. Also used to measure heights of surface features.
- Radio and Plasma Wave Spectrometer (RPWS) investigates plasma waves (generated by ionised gases flowing out from the Sun or orbiting Saturn), natural emissions of radio energy and dust.
- Radio Science Subsystem (RSS) searches for gravitational waves in the Universe; studies the atmosphere, rings and gravity fields of Saturn and its moons by measuring telltale changes in radio waves sent from the spacecraft.
- Ultraviolet Imaging Spectrograph (UVIS) measures ultraviolet energy from atmospheres and rings to study their structure, chemistry and composition.
- Visible and Infrared Mapping Spectrometer (VIMS) identifies the chemical compositions of the surfaces, atmospheres and rings of Saturn and its moons by measuring colours of visible light and infrared energy emitted or reflected.

The Huygens probe, carrying a payload of six specialised scientific instruments, was released on 25 December 2004. It descended by parachute through the atmosphere of Titan, landed on solid ground and returned 350 images.

The probe mission was controlled autonomously by the probe support equipment on the orbiter as it could not be controlled from Earth due to the long delay in communications. It typically takes about 80 minutes for signals to travel between Earth and Saturn depending on the orbital positions of the planets.

During flybys of moon Enceladus, Cassini observed water-ice geysers suggesting that Enceladus is supplying ice particles to Saturn's E-ring. Cassini provided direct evidence of small meteoroids breaking into the streams of rubble and crashing into Saturn's rings.

On 16 April 2008, the Cassini mission was extended by two years as the Cassini Equinox Mission, which would allow a considerable number of additional orbits of Saturn and flybys of moons Titan, Enceladus, Dione, Rhea and Helene. In



February 2010 this was further extended as the Cassini Solstice Mission. This allowed another 155 orbits of Saturn, 54 flybys of Titan and 11 flybys of Enceladus. The gallery of close up colour photos of several of the moons is phenomenal. Saturn has 53 named moons and another 9 are being studied. The moon Titan is larger than planet Mercury. Thirteen of the moons are from 10 to 50 km in diameter and 33 are less than 10 km.

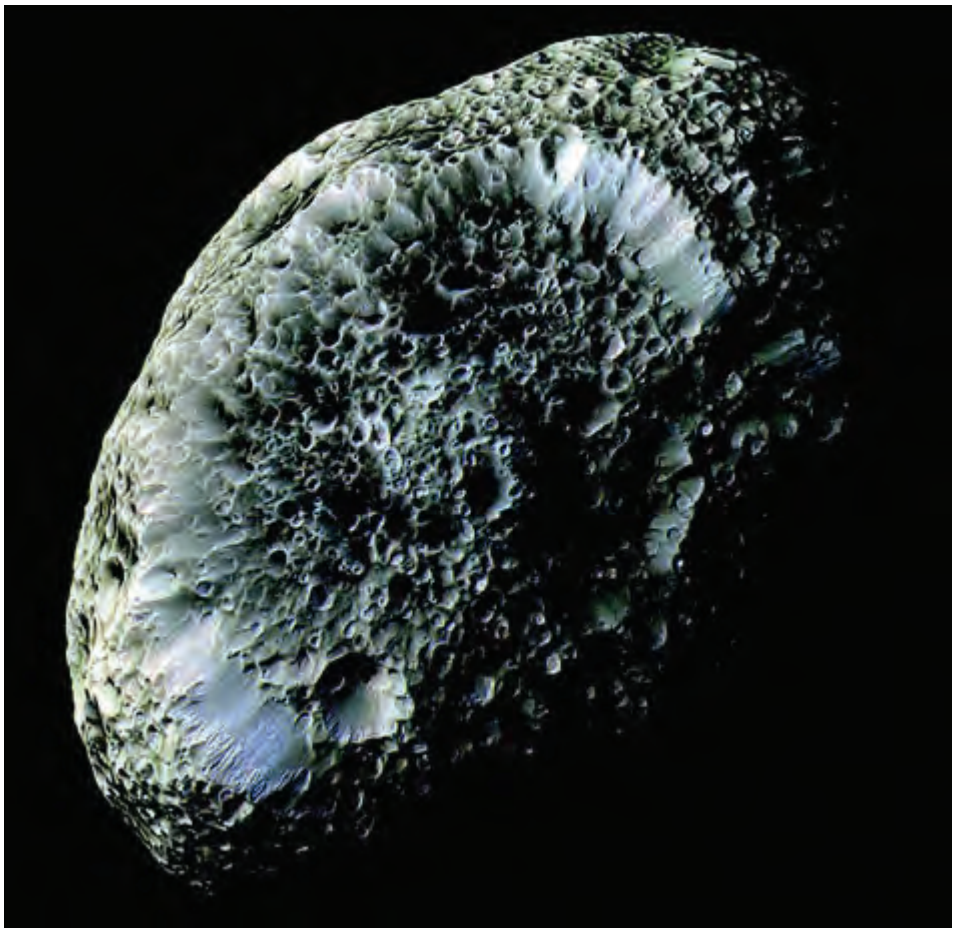
As of its 10th anniversary in Saturn orbit, July 2014, Cassini has beamed back to Earth more than 514 gigabytes of scientific data through NASA's Deep Space Network, enabling the publication of more than 3,000 scientific papers. Cassini has completed more than 200 orbits of Saturn, carried out 132 close flybys of Saturn's moons and discovered seven new moons.

On 31 May 2015 Cassini took a remarkable photo of moon Hyperion showing it to be one of the most bizarre objects in the Solar System.

Images of the small moons Atlas and Pan showed them to have pronounced bulges around their equators.

Every 20 to 30 years, Saturn's atmosphere roils with giant, planet-encircling thunderstorms that produce intense lightning and enormous cloud disturbances. The head of one of these storms - popularly called "great white spots", in analogy to the Great Red Spot of Jupiter - can be as large as Earth. Unlike Jupiter's spot, which is calm at the centre and has no lightning, the Saturn spots are active in the centre and have long tails that eventually wrap around the planet.

Six such storms have been observed on Saturn over the past 140 years, alternating between the equator and mid latitudes, with the most recent emerging in December 2010 and encircling the planet within six months. The storms usually occur when Saturn's northern hemisphere is most tilted toward the sun. Just what triggers them and why they occur so infrequently, however, has been unclear.



Saturn's Moon, Hyperion

An unusual object seen in the A-ring is known as the "Earhart propeller". This propeller is seen in this view from NASA's Cassini spacecraft at much higher resolution than ever before. This view, obtained on March 22, 2017, is the second time Cassini has deliberately targeted an individual propeller for close-up viewing during its ring-grazing orbits, after its images of Santos-Dumont (PIA21433) a month earlier. The biggest known propeller, informally named "Bleriot," is slated for the third and final propeller close-up in April 2017.

Propellers are disturbances in the ring caused by a central moonlet. The moonlet itself would be a few pixels wide in this view, but it is difficult to distinguish from (and may be obscured by) the disturbed ring material that surrounds it.

The detailed structure of the Earhart propeller, as seen here, differs from that of Santos-Dumont. It is not clear whether

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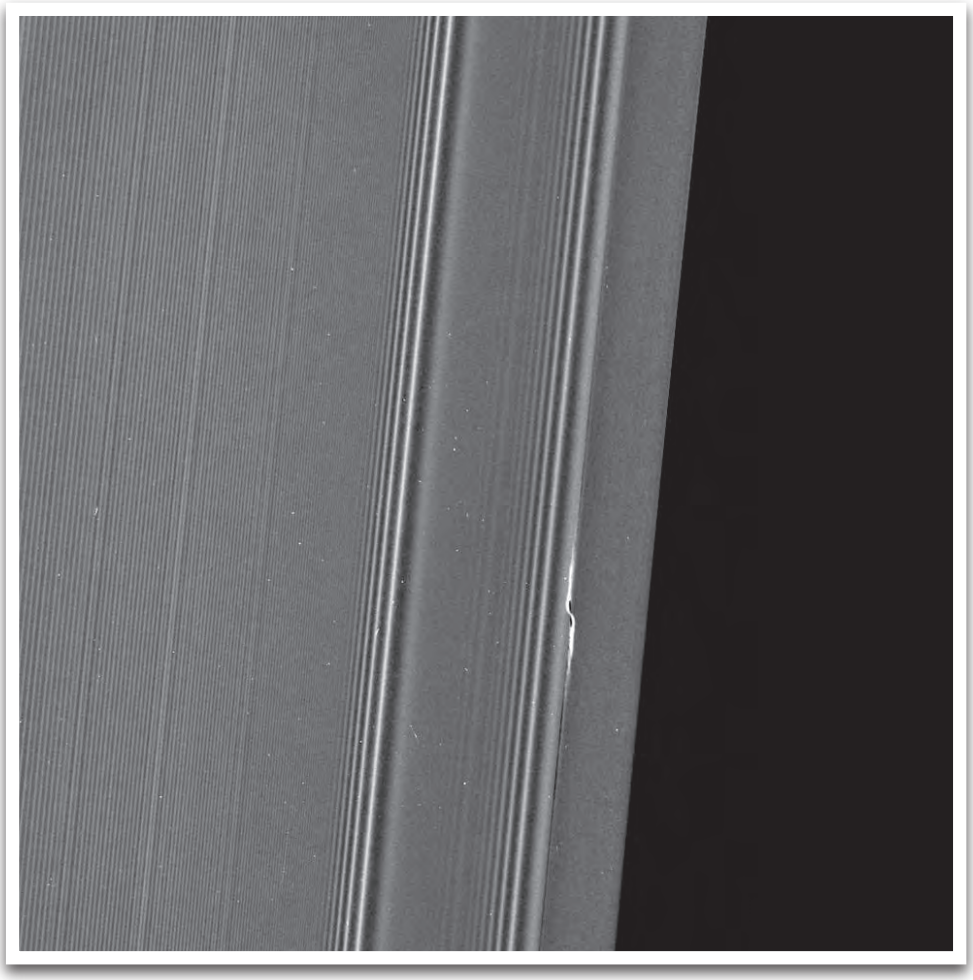


A close up view of the 'Earhart Propeller'.

these differences have to do with intrinsic differences between Earhart and Santos-Dumont, or whether they have to do with different viewing angles or differences in where the propellers were imaged in their orbits around Saturn.

Earhart is situated very close to the 200-mile-wide (320-kilometer-wide) Encke Gap, which is held open by the much larger moon Pan. In this view, half of the Encke Gap is visible as the dark region at right.

The gap and the propeller are a study in contrasts. The propeller is nothing more than Earhart's attempt to open a gap like Encke using its gravity. However, Earhart's attempt is thwarted by the mass of the ring, which fills in the nascent gap before it can extend very far. Pan is a few thousand times more massive than Earhart, which enables it to maintain a gap that extends all the way around the ring.

To the left of the propeller are wave features in the rings caused by the moons Pandora, Prometheus and Pan.

The visible-light image was acquired by the Cassini narrow-angle camera at a distance of 69,183 miles (111,340 kilometers) from the propeller feature. Image scale is 0.4 mile (670 meters) per pixel in the radial, or outward-from-Saturn, direction. The view looks toward the sunlit side of the rings.

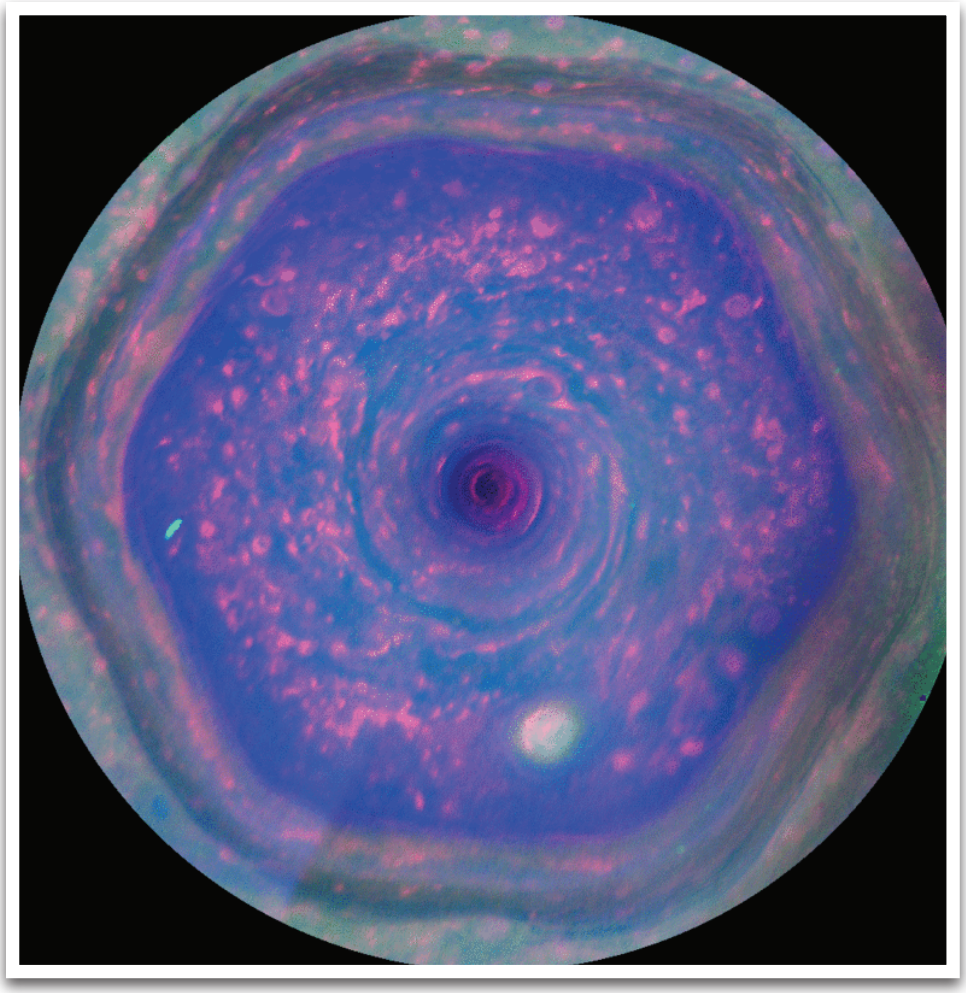
On 25 October 2016 a new image of Saturn's giant hexagonal north pole storm was posted. This was originally detected by the Voyager spacecraft in the early 1980s but has been shrouded in darkness for some 15 years. It was not possible for Voyager to obtain an out-of-ecliptic view of the hexagon. The hexagon spans some 32 000 km and extends 100 km down into the planet's dense atmosphere. Scientists estimate that this storm has been raging for decades, possibly centuries.

Titan is Saturn's largest moon, which was discovered by Christiaan Huygens on 25 March 1655. With a diameter of 5151 km it is larger than planet Mercury (4879 km) and the Earth's Moon (3474 km) and is the only moon known to have a dense atmosphere.

Little was known about Titan before 2004. The Cassini mission has revealed that it has lakes and seas of liquid methane and ethane, replenished by rain from hydrocarbon clouds. There is also evidence that Titan has an internal ocean of water and ammonia. The Huygens probe measured radio signals during its descent which suggested the presence of an ocean 55 to 80 km below the surface. The complex chemistry suggests that Titan may have the potential for supporting life of some kind.

Enceladus is Saturn's sixth largest moon with a diameter of 504 km.

Cassini has made 22 flybys of Enceladus. Starting in 2005, Cassini detected surprising geological activity. The final flyby took place on 19 December 2016 passing within



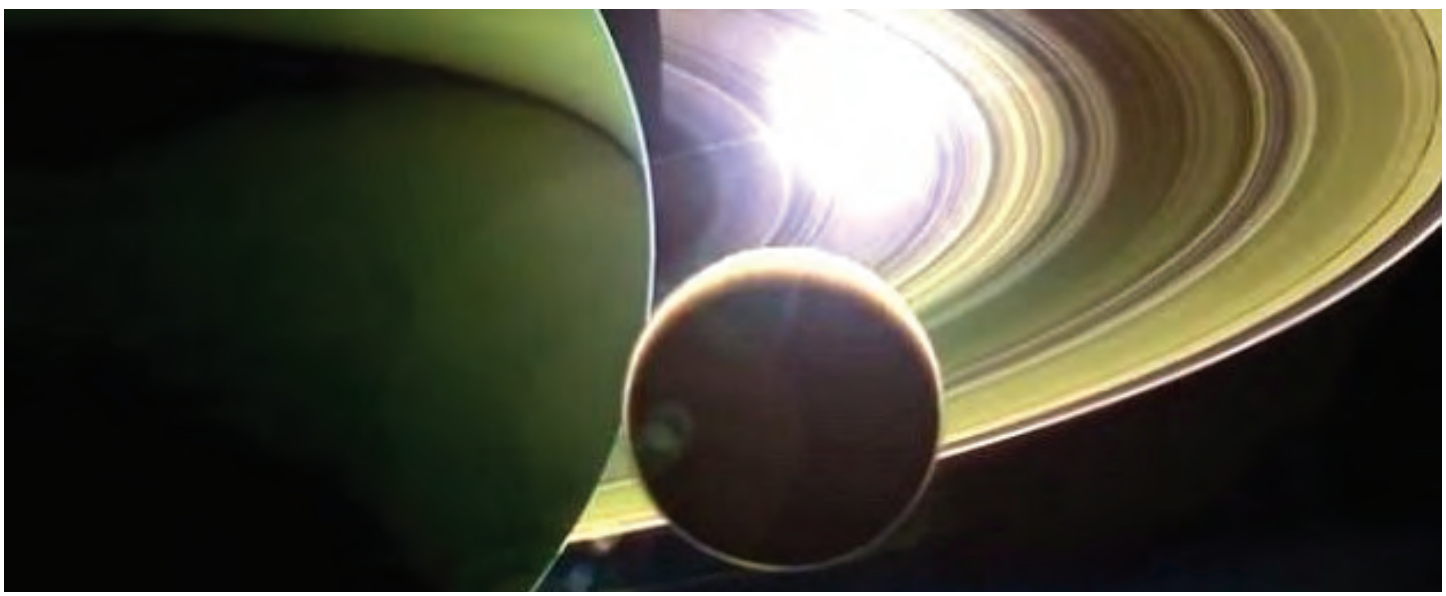
Saturn's giant hexagonal north pole storm

4999 km of the moon. Enceladus is now known to have an ice shell of 18 km to 22 km thick with a thickness of less than 5 km at the south pole, covering a global ocean which is warmer than expected.

The hydrothermal activity with vents spewing water vapour and ice particles have indicated organic compounds, volatile gases, carbon dioxide, carbon monoxide, salt and silica, as well as hydrogen gas, said to be the missing ingredient for life.

Hydrogen gas is now said to be a potential source of chemical energy that could support single celled microbes on the sea floor of Enceladus, which are still found on Earth, using hydrogen and carbon dioxide as fuel in a process known as 'methanogenesis'.

On 26 April 2017 Cassini started the first of its Grand Finale dives towards Saturn. Cassini is running out of thruster fuel and will make a spectacular plunge into Saturn. Cassini could not be allowed to



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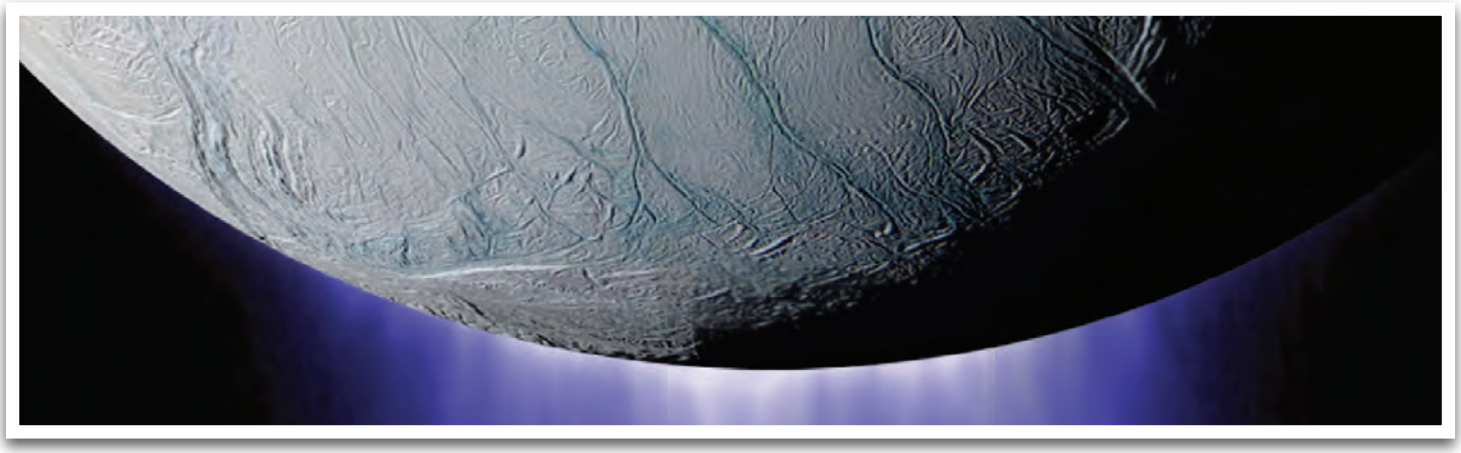

Images were acquired of the Enceladus surface jets with the Cassini spacecraft narrow-angle camera on 27 November 2005 at a distance of approximately 148 000 kilometres.

remain out of control in orbit as it could potentially contaminate the moons and rings, thwarting future missions searching for fundamental signs of life. When passing through the narrow 2000 km gap between Saturn and its rings, the craft was travelling at some 124 000 km/hour relative to the planet.

In order to protect it from small particles, the craft was turned to use the large high-gain antenna as a shield, after which communications were again restored, beaming back scientific and engineering data. Cassini captured a sensational image of the 2000 km diameter 'dark storm' at the centre of the polar vortex and hexagon. Cassini's next dive through the gap was scheduled for 2 May 2017. It is expected that Cassini will make a total of 22 dives between the rings and the planet before its final plunge on 15 September 2017.

Jim Green, director of the Planetary Science Division at NASA Headquarters in Washington declared: *"In the grandest tradition of exploration, NASA's Cassini spacecraft has once again blazed a trail, showing us new wonders and demonstrating where our curiosity can take us if we dare."*

The current end of mission plan is a fiery plunge into Saturn in September 2017, after nearly two decades of faultless operation. The magnificent and hugely successful Cassini-Huygens Mission is a masterpiece of state of the art engineering and technology. This mission stands tall amongst the most ambitious and successful space missions ever launched. wn

For more information, audio and video, visit:

www.nasa.org.gov
www.space.com
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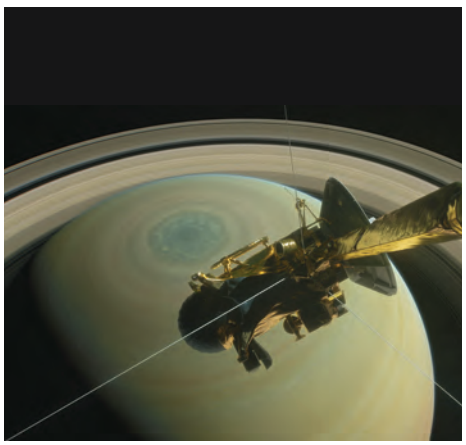
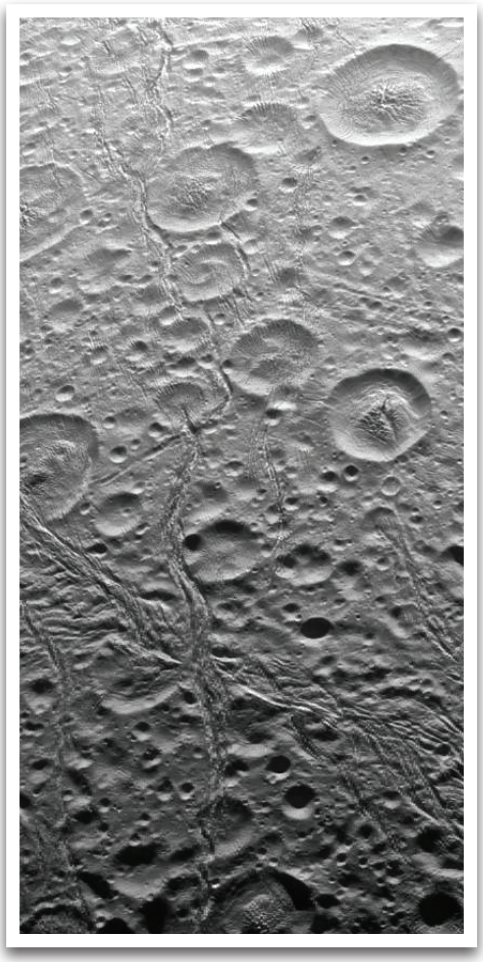
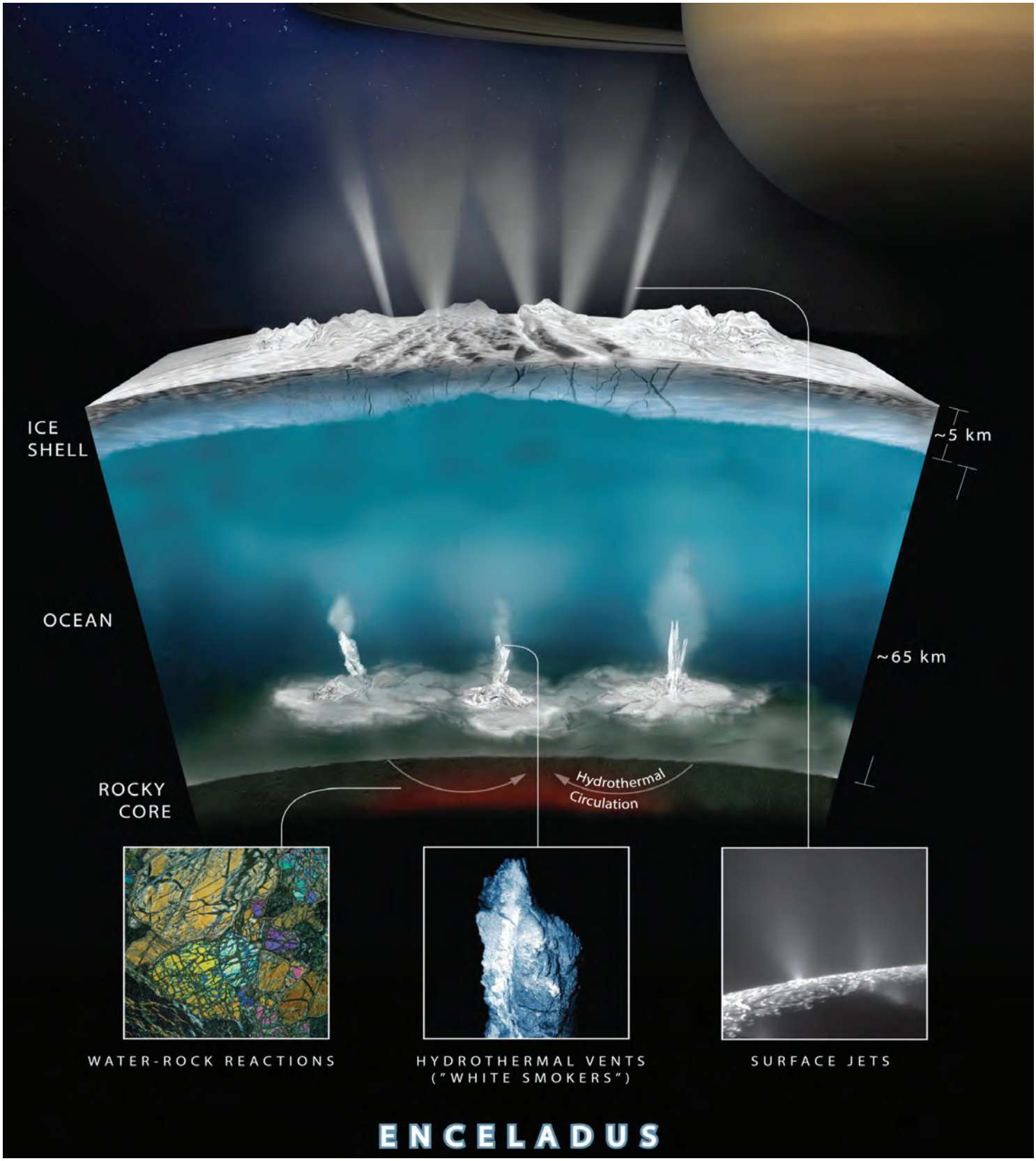




An image of the Enceladus north pole, dotted with craters and quite unlike the south pole


ICE SHELL
~5 km
OCEAN
~65 km
ROCKY CORE
Hydrothermal Circulation
WATER-ROCK REACTIONS
HYDROTHERMAL VENTS ("WHITE SMOKERS")
SURFACE JETS
ENCELADUS

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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!

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 is a master/follower system?

ANSWER ONE

In a master/follower system, more than one electrical motor must work together to drive a common load. This is not as easy as it may seem, and normal motor installations will not suffice. It is actually possible that through the drive trains (gearboxes/belts/pulleys) small differences may exist. These differences will easily result in one motor performing all the work, and failing on overload, while the other motor/s exert little to zero force on the load.

To accomplish this load sharing between multiple motors, an exact speed reference matching will also not work, since the small differences in drive trains may require one machine running faster in order to exert the same force on the load. A means of measuring the force (torque) of one machine, referred to as the master, is necessary. The torque feedback can be sent to the controlling equipment (variable speed drives) as a reference for the other variable speed drives, referred to as the followers. The speed reference of the followers needs to always be higher than the overall speed reference of the system or master, in case as stated above they need to run faster to share the load. Note that it is also possible that the followers will need to run slower in order to share the load. The main task of the followers is to run at any required speed until the torque is equal or slightly less than that of the master.

QUESTION TWO

How does this work technically?

ANSWER TWO

Generally Variable Speed Drives (VSD) are utilised since they can vary speed and offer a lot of functions. The torque of the master drive is communicated to the followers via its analogue output to the analogue inputs on these followers. The speed reference on the followers can be either communicated in the same way, or the speed references of the followers could simply be set at maximum value, which must be roughly 10% higher than the maximum speed at which the master will run (known as speed saturation). The torque reference

of the master now becomes an input on the follower drives and the maximum torque at which they can run. This torque limit, but with saturated speed reference on the followers, will ensure that they run as fast as necessary until the torque output is the same as that of the master, but not faster. The torque on each motor shaft now automatically becomes the same and the goal is met, the motors are sharing the load equally ensuring that each motor delivers the same amount of torque to drive the load.

QUESTION THREE

What are the advantages compared to using a single larger motor?

ANSWER THREE

Using these multiple smaller motors, instead of a single larger motor to drive the load, has some advantages, and makes this solution quite common in many applications. Depending on the size of the application, a large motor may take the supply voltage into the medium voltage range, where cost becomes noticeably higher. Space may also be an issue, where one large motor cannot fit, but a few smaller motors placed around the driven load is possible. Rigging may also become a nightmare depending on the location, where multiple smaller motors are easier to move around and get into place, especially if one larger motor also implies one larger gearbox etc. and many pieces of equipment now must be handled. When using multiple smaller motors there is also the possibility for back up redundancy. If you only have one large motor and for some reason it fails the production will have to be stopped, in the case of multiple motors the system can often run at a reduced load but still keep production going.

QUESTION FOUR

Is there more than one way of achieving this?

ANSWER FOUR

The best way of achieving a very good, near perfect load sharing of the multiple motors, is to have them each fitted with an encoder and to run them in what is referred to as closed loop vector mode. This is a good control mode, which enables inverters to achieve precise speed and torque control. Another control mode is also possible where no communication between the VSDs is necessary. In this mode open loop vector control without encoders is possible. Each VSD will increase motor slip as the torque value increases, and this, in turn, will ensure that motors running with less torque will catch up, or simply run faster since their slip values will be lower. This will form a rough torque sharing philosophy, not perfect as with encoders but acceptable in some cases.

Communications between the inverters, where the torque values and start signals are to be shared, can also be achieved in different ways. The first being analogue (for torque and speed), and digital (for start signals and interlocking). The other option is to utilise communication cards and PLC functionality on the VSDs. The start/stop interlocking, speed and torque values can be sent digitally between the units, making control even more accurate, and also allowing more functionality and protection to be added without more cabling required. wn

Information provided by Zest WEG Group

June

Movers, shakers and history-makers

COMPILED BY JANE BUISSON-STREET
FSAIEE | PMIITPSA | FMIITSPA

1 JUNE

1943 According to an entry in the squadron's diary, 28 Squadron of the SA Air Force was formed as a transport squadron at the SAAF Base Depot Almaza, Cairo.

2 JUNE

2003 Mpumalanga game ranger, Sibusiso Vilane, became the first Black South African to conquer Mount Everest, the world's highest peak.

3 JUNE

1954 South Africa's richest gold deposit was discovered near the farm Erfdeel in the Orange Free State.

4 JUNE

1966 Senator Robert Kennedy arrives in South Africa as the guest of NUSAS (National Union of South African Students) to deliver its Annual Day of Affirmation Speech to be held that year at the University of Cape Town.

5 JUNE

2006 The Johannesburg Stock Exchange (JSE) listed itself and, staying true to tradition, asked those invited to the listing breakfast to wear hats.

6 JUNE

1966 Senator Robert Kennedy's speech at the University of Cape Town is by far the best known of his South African speeches, and is considered by most to be the greatest speech of his life. One paragraph in particular remains one of the most quoted paragraphs in American politics:

"It is from numberless diverse acts of courage and belief that human history is shaped. Each time a man stands up for an ideal, or acts to improve the lot of others, or strikes out against injustice, he sends forth a tiny ripple of hope, and crossing each other from a million different centres of energy and daring those ripples build a current which can sweep down the mightiest walls of oppression and resistance."

7 JUNE

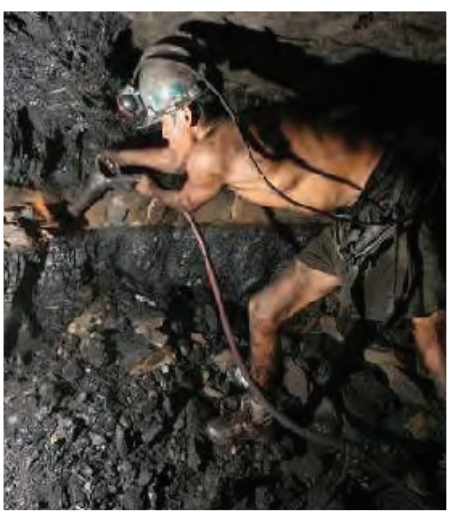
1989 US company Goodyear, South Africa's biggest tyre manufacturer, sold its local operations for R178-million. The operation was taken over by Anglovaal's packaging subsidiary, Consol.

8 JUNE

1860 The first of five post-boxes were erected in the Cape. One of these post-boxes is still in use in Grahamstown.

9 JUNE

1991 Twenty-six miners were trapped when a roof collapsed at the Emaswati Coal Mine near Mpaka, Swaziland. The fastest way to get the miners out was through the use a drill which the Mine's management immediately requested from South Africa's Chamber of Mines. The Ingersoll-Rand rescue drill was kept at Witbank, Mpumalanga.



10 JUNE

1977 Apple Computer Inc. shipped its Apple II computer. This was the first in a long line of related computers. The original model cost $1,298 and came with 4KB of RAM (upgradeable to 48KB), and had sound as well as colour graphics. It also had BASIC Programming Language built-in.

11 JUNE

1830 The new organ in the Groote Kerk in Cape Town, a gift from Jan Hoets, was inaugurated. The organ was manufactured by Bevington, an English firm. This organ was refurbished twice, in 1887 and 1923, and then replaced in 1953.

12 JUNE

1963 This was the coldest day Pretoria had experienced in 108 years with a minimum of –3.6˚C and a maximum of 7.5˚ Celsius.

13 JUNE

2005 South African engineer, Nuno Gomes, entered the Guinness Book of Records for mankind's deepest seawater dive ever on 13 June 2005. Gomes's 318.25m plunge beat the record of 313m, set by Mark Ellyatt in Thailand in 2003. His target was a depth of 320, but he only managed 318.25, which still proved good enough for a world record. It took Gomes only 20 minutes to descend, but returning to the surface took an agonising 12 hours. Nuno held this record until 2014.

14 JUNE

1996 Finance Minister Trevor Manuel unveiled the government's macro-economic strategy in a framework document entitled Growth, Employment and Redistribution (GEAR).

15 JUNE

1844 Charles Goodyear was granted patent #3,633 for vulcanized rubber.

16 JUNE

1963 Valentina Tereshkova, a Russian Cosmonaut and a member of Soviet Space Program's Vostok 6 Mission, became the first woman in space.

17 JUNE

1893 A borehole at the Rand-Victoria Mine near Germiston struck the Main Reef of the Witwatersrand Gold Fields at 731 metres, becoming the most celebrated of several boreholes to prove that vast tonnages were ready for development at great depth.

18 JUNE

1948 Columbia Records introduced the long-playing (LP) record album in a public demonstration at the Waldorf-Astoria Hotel in New York City.

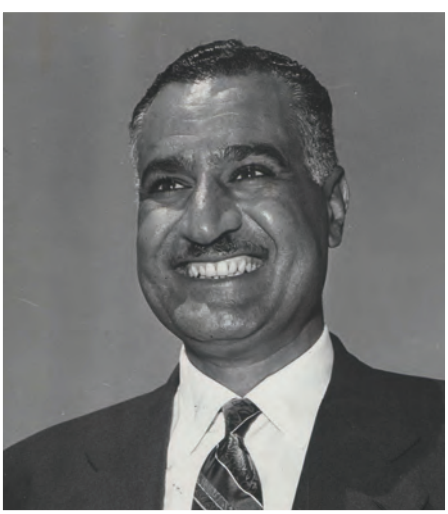
19 JUNE

1811 William John Burchell, an English explorer, naturalist, traveller, artist, and author, left Cape Town with a specially built wagon on a journey. While on his four-year journey he collected over 50,000 specimens, and covered more than 7,000 km, much over unexplored terrain.

20 JUNE

1961 General Nasser, president of Egypt, announced a plan to protect the ancient temples at Abu Simbel by moving them to a nearby site above the expected floodwater level of the Aswan Dam.

Abu Simbel is the site of two rock-cut temples of Rameses II the facade of the largest one is particularly known for its gigantic seated figures. The complex was relocated in its entirety in 1968, to an artificial hill made from a domed structure, high above the Aswan High Dam reservoir.



JUNE

continues from page 63

21 JUNE

1965 Gary Player won the US Open Golf Tournament and became the fourth winner to earn all four top-pro golf titles. Player was the first non-American to achieve this feat.

22 JUNE

1940 About 10,000 Afrikaner women, led by Mrs H.C. Steyn, wife of former President M.T. Steyn, marched to the Union Buildings to protest about the South African involvement in World War II.

23 JUNE

1996 Archbishop Desmond Tutu retired as Archbishop of Cape Town and head of the Anglican Church in South Africa.

24 JUNE

1963 The first demonstration of a home video recorder took place at BBC Studios in London, England.

25 JUNE

1927 Michael Miller and Sam Cohen opened the first OK Bazaars on Eloff and President Streets in Johannesburg.

26 JUNE

1948 William Shockley filed the original patent for the grown-junction transistor, the first bipolar junction transistor.

27 JUNE

1929 The first mechanically scanned colour television was demonstrated by Bell Laboratories using three complete systems of photoelectric cells, amplifiers, glow-tubes, and colour filters, with a series of mirrors to superimpose the red, green, and blue images into one full colour image.

28 JUNE

1995 There was an announcement that three of South Africa's nine provinces would have name changes: PWV becomes Gauteng; Orange Free State becomes the Free State and the Northern Transvaal becomes the Northern Province. Northern Province has since changed its name again to Limpopo Province. This was because it was found that the province shares the name with other provinces in other African countries, which was causing confusion for international investors.

29 JUNE

1905 Alphaeus Hamilton Zulu, Bishop of Zululand and later President of the World Council of Churches (WCC), is born in Nquthu, Natal. He was a member of the Zulu Royal Dynasty.

30 JUNE

1921 The South African Reserve Bank (SARB) opened for business. The SARB was the fourth central bank established outside the United Kingdom and Europe, the others being the United States, Japan and Java. wn

calendar

JUNE | JULY | AUGUST 2017

JUNE 2017

5 - 9	Earthing Africa Symposium & Exhibition	Johannesburg	www.earthingafrica.co.za
7	Power Transformer Unit Protection And Testing	Johannesburg	roberto@saiee.org.za
8	Power Transformer Operating And Maintenance	Johannesburg	roberto@saiee.org.za
7 - 8	Fundamentals of Long Term Evolution (LTE) Mobile Communications	Johannesburg	roberto@saiee.org.za
14 - 15	Optical Fibers, Cables & Systems Fundamentals	Johannesburg	roberto@saiee.org.za
13 - 15	ORHVS - Operating Regulations For HV/MV Systems	Johannesburg	roberto@saiee.org.za
13 - 18	Sustainability Week	Pretoria	www.sustainabilityweek.co.za
19	ELPA Launch	Johannesburg	www.elpa.org.za
22 - 23	High Voltage Testing & Measurements	Johannesburg	roberto@saiee.org.za
28 - 29	Fundamentals Of Practical Lighting Design	Johannesburg	roberto@saiee.org.za

JULY 2017

4 - 5	Photovoltaic Solar Systems	Johannesburg	roberto@saiee.org.za
12 - 13	HV/MV Circuit Breaker, Operating & Maintenance		
12- 14	Planning Strategic Feasibility Studies	Johannesburg	roberto@saiee.org.za
12 - 14	West Africa Power Summit	Senegal	www.wafpower.com
18 - 20	PowerGen Africa	Johannesburg	www.powergenafrica.com
19 - 20	Network Frequency Control with Increasing Renewable Power Plants	Johannesburg	roberto@saiee.org.za
19 - 21	Smart Meters for Smart Grid Training	Johannesburg	roberto@saiee.org.za
24 - 26	Fundamentals of MV Protection	Johannesburg	roberto@saiee.org.za
26 - 28	Substation Design & Equipment Selection	Johannesburg	roberto@saiee.org.za

AUGUST 2017

2 -3	Leadership & Management Principles & Practice in Engineering		
2 - 3	Internet of Things (IoT)		
3 - 5	NOCCI Business Expo	Kimberley	www.nocci.co.za
4 - 6	Empire Money Expo	Johannesburg	www.themoneyexpo.co.za
7 - 9	Rapid Underground Mine and Civil Access Conference	Johannesburg	www.saimm.co.za
11	Application of LV Frequency Control to Industrial Drives	Johannesburg	roberto@saiee.org.za
15	Smart Buildings & Infrastructure Western Cape Summit	Cape Town	www.smart-summit.com
16 - 17	Fundamentals of LTE Mobile Communication	Johannesburg	roberto@saiee.org.za
16 - 17	Fundamentals of Power Distribution	Johannesburg	roberto@saiee.org.za
23 - 24	Incident Investigation & Management (Including Root Cause Analysis)	Johannesburg	roberto@saiee.org.za
23 - 24	Fundamentals of Developing Renewable Energy Plants	Johannesburg	roberto@saiee.org.za

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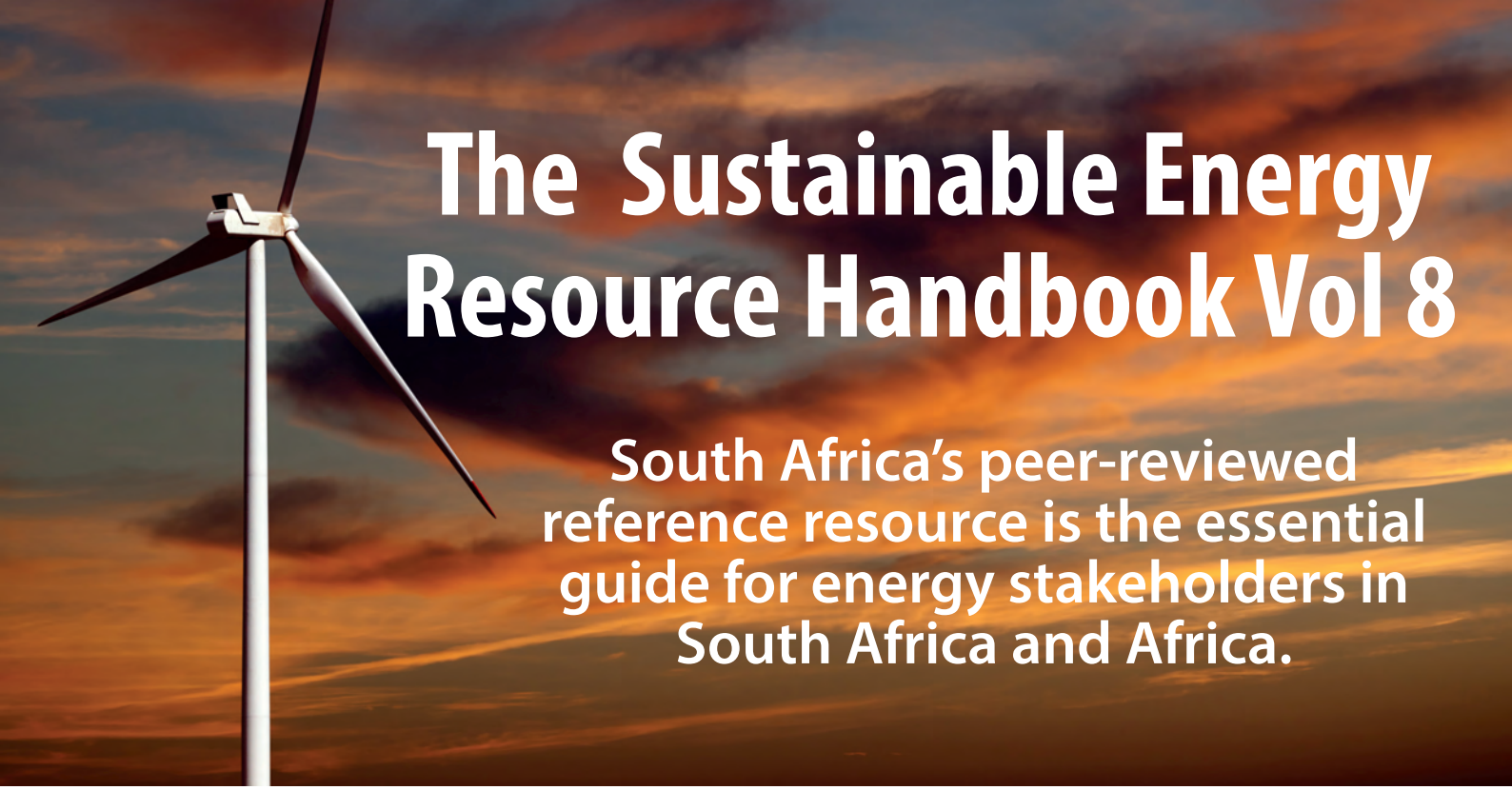

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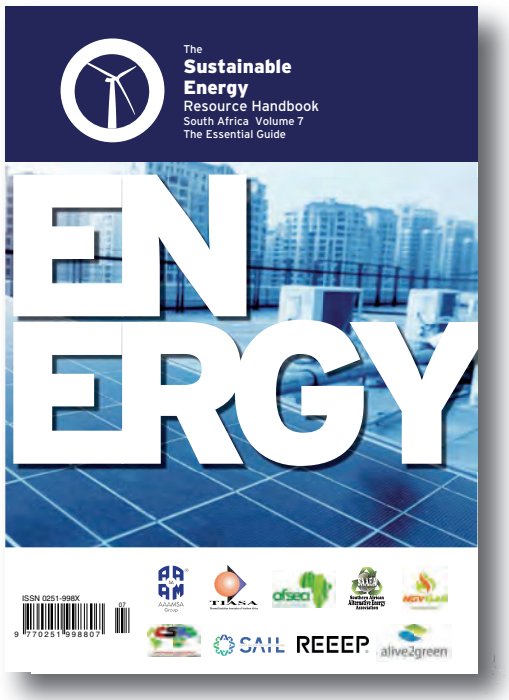

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