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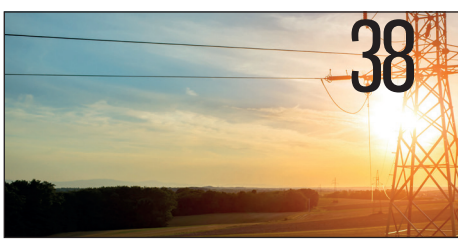

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It is August, the month during which we celebrate women. The SAIEE hosted a number of ladies at our head office on the 8th of August, and it was a resounding success. Read more on page 8.

This issue of the **watt**now deals with a topic very close to my heart – and that is Lightning and the protection of people and facilities. There are many myths about how to keep safe and as a result South Africa has the second highest fatality rate in the world due to Lightning.

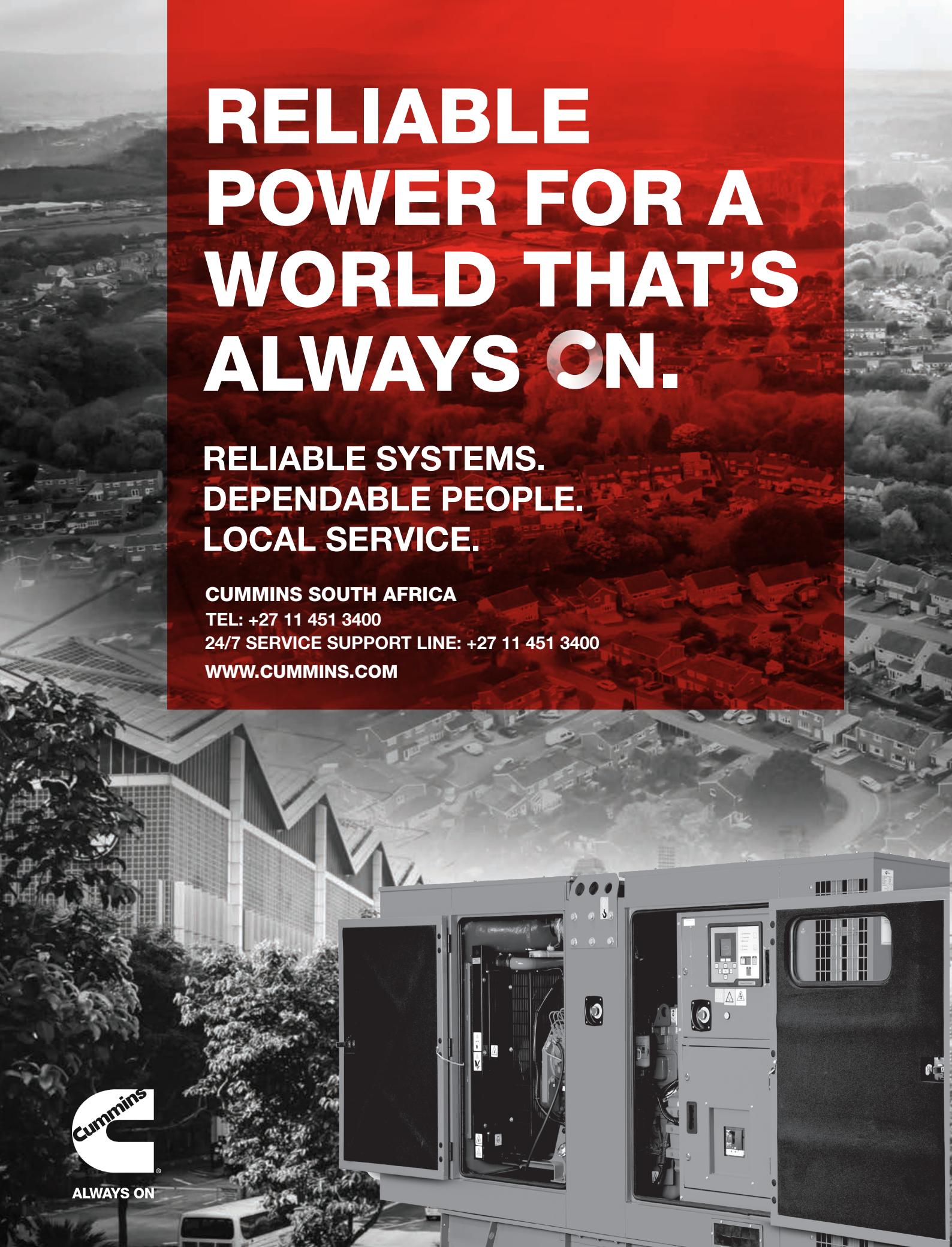
In this issue, experts share different facets of Lightning Protection. Our first feature article on page 18, written by Prof Chandima Gomes, entitled *"Lightning Safety Structures for Applications in the Industrial sector and Under-privileged Communities in Africa"* focuses on Africa and what can be done for keeping the people safe.

Our second feature article, written by Trevor Manas, takes another angle and focuses on different innovative ideas at protecting thatch roofs against lightning strikes. Read all about it on page 28.

Our last feature article, on page 38, is written by a team of experts from Eskom, titled *"Advantages and disadvantages of low lightning insulation level on overhead MV power lines"*. It focuses on how Eskom has standardised a phase-to-earth lightning insulation level of 300 kV on its medium voltage (MV) overhead distribution lines.

Herewith the August issue, enjoy the read!

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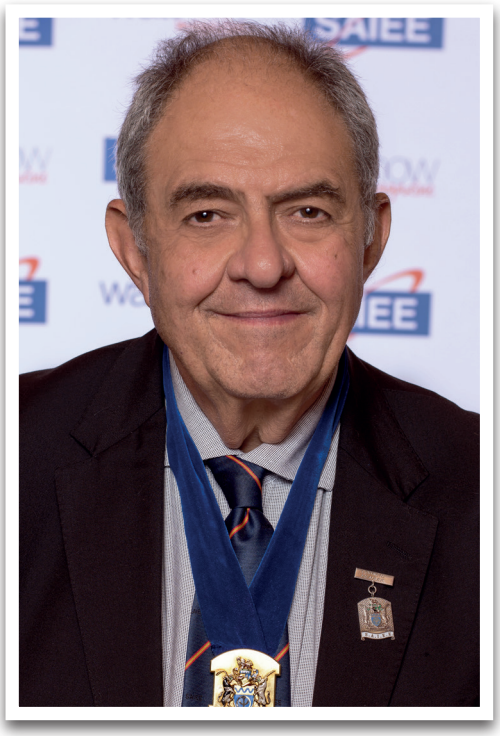


Landing on the Moon - Apollo 11

GEORGE DEBBO
2019 SAIEE PRESIDENT

On 20th July the world celebrated the 50th anniversary of the landing on the Moon. I can still recall that day as a young teenager getting up in the early hours of the morning and listening, together with my father, on the radio as Neil Armstrong and Buzz Aldrin stepped onto the Moon.

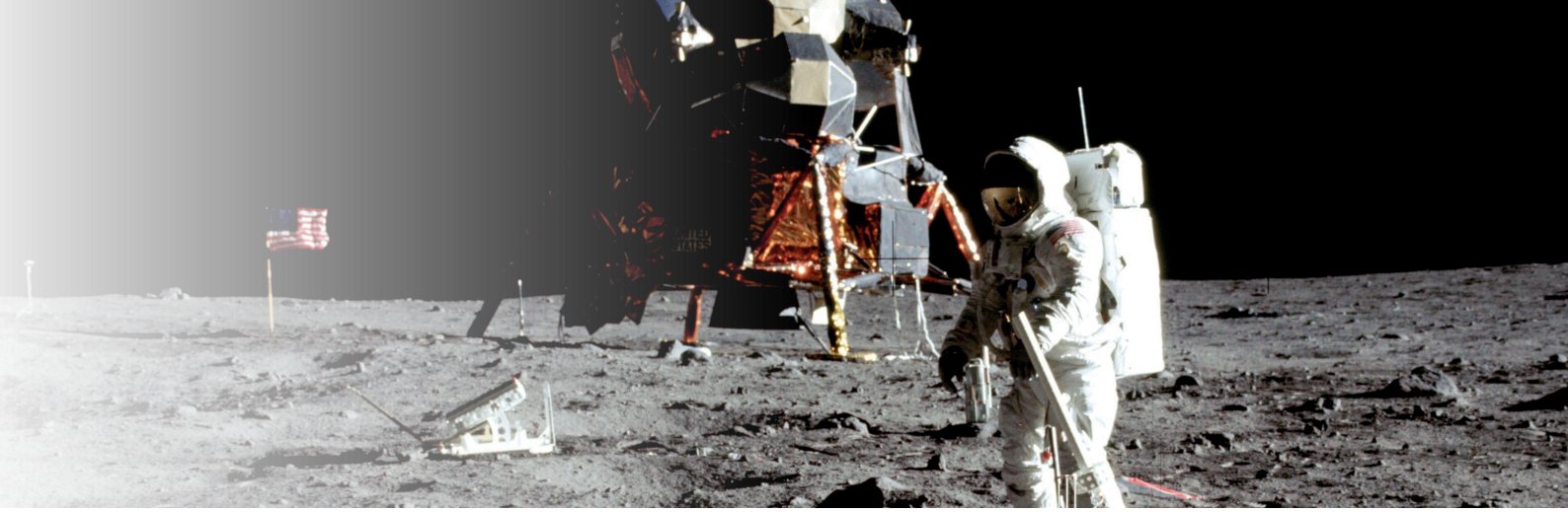
I am sure many of our younger readers will ask the question "Why did you listen to this historical event on the radio and not watched it on television, as did most of the rest of the world?" The answer is straightforward – South Africa did not have television (TV) in 1969!

The reason for this is that the then National Party government had introduced policy in the early 1960s declaring that television was not to be introduced in South Africa. The then Minister of Posts and Telegraphs, Dr Albert Hertzog, denounced TV as a miniature bioscope (Afrikaans term for cinema) and over which parents would have no control over what their children watched. He is on record as saying that TV would come to South Africa "over my dead body". In addition to Dr Hertzog's position regarding TV, the then influential Dutch Reformed Church also saw this new medium as degenerate and immoral. Luckily many South Africans did not share Dr Hertzog's conservative views, and the SABC was permitted in 1971 to introduce a television service into South Africa. Experimental broadcasts started in the main cities during mid-1975, following that the service went commercial and nationwide at the beginning of 1976. Back to Neil Armstrong's landing on the Moon, we did get to see it a few days later when videotapes arrived and were shown at the Johannesburg Planetarium.

Whenever I think of the landing on the Moon and the communication technology that was used in those days, and comparing to what is available today, I often think of Judas Iscariot's closing words in the Andrew Lloyd Webber and Tim Rice rock opera "Jesus Christ Superstar":
Why'd you choose such a backward time in such a strange land?
If you'd come today, you could have reached a whole nation
Israel in 4 BC had no mass communication

Although the ability to communicate to the masses in 1969 was available, it is worth considering the main technological developments that have taken place since then and how these would contribute to improving the quality of experience for the masses should the moon landing have taken place today.

The first is the significant improvement in quality and the ubiquitous distribution



of television. With regards to the latter and taken into account the introduction of cable TV and direct to home (DTH) satellite TV, all countries in the world today, irrespective of economic level, have access to multiple content channels. Factor in quality, there has also been a significant improvement since watching those grainy black and white TV images from the Moon in 1969. Today at the commercial level, we can provide 4K (ultra-high definition) TV using a resolution of 3840 x 2160 pixels. This is four times better resolution than that of high-definition TV. We will soon have 8K (7680 x 4320 pixels) commercially available.

In terms of bandwidth, 4K requires 25Mbit/s for live streaming, which would, with today's radio technology, not be a problem for transmission from the lunar service. However it is interesting to note that such capability was not available in 1969, and the radio communication solution that was used then had to be specifically designed to handle the massive amounts of information that had to pass between the spacecraft and the supporting ground crews. This included voice communication, telemetry, computer upload information for navigation and television. To achieve this, a radio solution called unified S-band or USB was developed by combining tracking, ranging, command, voice and television data into a single antenna. This differed from the solution that was used for the Gemini program where separate radio systems were used; one system used UHF and VHF to carry voice, uplinked data and downlinked telemetry, and the second system used a C-band transponder to provide tracking by integrating the spacecraft with ground-based radar.

With the USB solution voice and biomedical data were transmitted on a 1.25 MHz FM subcarrier, telemetry was handled using a 1.024 MHz bi-phase modulated subcarrier and ranging for the two spacecraft (command and lunar modules) was accomplished with a pseudo-random code using a phase-modulated S-band downlink frequency of 2287.5 MHz for the command module and 2282.5 MHz for the lunar module respectively.

To free up space for the television downlink that was used to broadcast from the Moon's surface NASA removed the ranging code and changed from phase to frequency modulation. Although this freed up 700 kHz of bandwidth, this was insufficient for the cameras that were used at that time which transmitted 525 scan lines of data at 30 frames per second and needed 5 MHz of bandwidth. To resolve this problem, NASA used a slow-scan camera that was optimised for a smaller format using 320 scan lines of data at ten frames per second that could be transmitted in 500 kHz of bandwidth. Back on earth, NASA used a scan converter to adapt the image to the broadcast standard format of 525 lines and 30 frames per second, and it was this translation that left the image grainy and degraded. However, these were still live footage of man's first steps on the Moon.

The second technological development that would have significantly improved the user experience associated with the landing on the Moon was the use of the Internet. The Internet has extended communication beyond that of voice to include email and messaging services. This capability will give the public the ability to interact directly and in real-time with the astronauts as has happened with some of the International Space Station missions. The Internet provides the public with a lot more information on the mission to the Moon in real-time.

The current indications are that man will return to the Moon by 2024 dependent upon the availability of budget and political support. The next mission to the Moon may well be funded by private companies such as Elon Musk's SpaceX or Jeff Bezos's Blue Origins. Whatever the economic and business means by which we will return to the Moon what is certain is that the public's experience of this event will be a lot different to the original mission due to the significant advancements that have taken place in communications technology since then.

G Debbo | SAIEE President 2019
Pr. Eng | FSAIEE

SAIEE Women's Breakfast

As is the norm, August comes around every year and along with it SAIEE's Women in Engineering Breakfast. The attendees this year ranged from Student Members to Fellows of SAIEE, non-members as well as three distinguished, knowledgeable and entertaining guest speakers.

SAIEE President, Mr (yes, Mr) George Debbo, began the proceedings by welcoming everyone to the event. Sy Gourrah, SAIEE Deputy President, then took over the podium and introduced Ms Dolly Mokgatle, the keynote speaker and Executive Director of Peotona Group Holdings who entertained the attendees while addressing Empowering women in the energy sector. The required paradigm shifts! Believe me when I say she positively sparkled as she spoke passionately to us about her varied experiences and spared no punches as to what we, as women, owe ourselves as well.

Ms Elsie Pule, Eskom Group Executive Human Resources, spoke about Work-Life Balance during which we were regaled with stories of motherhood, career changes/ progression and life in the energy sector.

The final speaker of the morning was Professional Image and Etiquette Consultant, Ms Doris Msibi, who gave us guidelines on how to be the best version of ourselves by telling us snippets as to how she, the mother of three, has lived and reinvented herself in ways we could all relate to.

The formal proceedings were wrapped up by Prudence Madiba. After that, nourishment (both consumable and retail therapy) and networking were the order of the day.

The SME's who joined us on the day had their goods on display ready for selling. They were:

PeaKaBag PeaKaStyle is a division of ReboPea Pty Ltd., owned by Makaepea Peta. They sell different types of bags (which they import) and handmade ladies' fascinators/ hats (which they make themselves.).

No modern slave by Kgosi is a fashion movement that aims to encourage african pride through his clothes. He uses khoisan and setswana elements in his work. A fashion artist who wishes to change the fashion scence with his narritive... The Kgosi Kimomo is his most commercial item.

Honey Jewellers and a few more SME's were amongst those taking care of our guests.

From left: Amelia Mtsali (SAIIEE Council Member), George Debbo (SAIEE President), Sy Gourrah (SAIEE Deputy President), Dolly Mokgatle (Executive Director, Peotona Group), Elsie Pule (Eskom Group Executive, Human Resources), Tshego Cornelius (SAIEE Council Member) and Prudence Madiba (SAIEE Council Member).

From left: Doris Msibi (Professional Image and Etiquette Consultant) and Sy Gourrah (SAIEE Deputy President).

From left: Prudence Madiba, Dolly Mokgatle and Sy Gourrah.

From left: Prudence Madiba, Eslie Pule and Sy Gourrah.

Makapea Peta were selling her imported purses and handbags.

Honey Jewellers were selling jewellery at the event.

Handmade dresses and head scarves were a hit amongst the ladies.

Hand-beaded salad spoons is always a favourite gift.

These two Gentlemen from No Modern Slave by Kgosi were displaying their designer dresses.

INDUSTRY AFFAIRS

CESA Aon Awards celebrating 25 years of Democracy

CESA Aon Awards celebrating 25 years of Democracy in the quest for excellence in engineering!

14th August 2019 In a night celebrating Excellence in Engineering hosted by Consulting Engineers South Africa (CESA) and sponsored by Aon South Africa, leaders in the Built Environment gathered at the Vodacom Dome in Midrand to honour 25 years of democracy and celebrate the winners of the 2019 CESA Aon Engineering Excellence Awards – reshaping our future together.

"Given the pivotal role that infrastructure development plays in the South African economy in achieving the goals of the National Development Plan and Vision 2030, as stated in President Cyril Ramaphosa's recent State of the Nation Address (SONA) these awards highlight the role that Consulting Engineers and their Clients play in providing Excellence in Engineering for economic development and job creation," states CESA CEO, Chris Campbell.

"An enormous responsibility lies upon your shoulders as the consulting engineers in South Africa, but by the same token, to deliver on these responsibilities, consulting engineers have to operate in a secure, risk-managed environment. It's our role at Aon South Africa to facilitate that environment, and to ensure that you have a professional and qualified team on your side, every step of the way," says Terence Williams, CEO of Aon South Africa.

Awards were handed out in the following categories: Lifetime Industry Achievement Award; Young Engineer of the Year; Engineering Excellence for projects with a value of less than R50million; projects between R50million and R250million and for projects with a value of over R250million; Roads and Bridges Projects; Best International Project; Visionary Client of the Year; Small Company of the Year; Mentor of the Year; Business Excellence; Mentoring Company of the Year; Publisher of the Year; Job Shadow Initiative; and Branch of the Year.

ABB names Björn Rosengren as CEO

The Board of ABB has unanimously appointed Björn Rosengren, as Chief Executive Officer. He will join ABB on February 1, 2020 and succeed CEO, Peter Voser, in this role on March 1, 2020. At that time Peter Voser will revert to his position at ABB solely as Chairman of the Board.

Björn Rosengren (60), a Swedish citizen, is a highly experienced, international executive and leader of industrial businesses. He has been the CEO of Sandvik, a high-tech global engineering group, since 2015. During this time, he has overseen the successful implementation of a decentralized structure and improved both the profitability and financial strength of Sandvik.

Björn Rosengren, said: "I look forward to working with my new colleagues around the globe to enhance value through the delivery of the group strategy and fully empowering our businesses and people."

SAIEE Student Career Day at Nyanga SS School at Engcobo

Nyanga SS School Students explored career opportunities as well as SAIEE support and services at a career day held at Nyanga Senior Secondary School at Engcobo on the 14 June 2019. Nyanga SSS set up a table in the school hall with a panel of professionals who talked with students about careers and future opportunities.

It gave me great pleasure to represent SAIEE on this career day. I delivered the 30 minutes presentation. After presentations according to the MC, Electrical Engineering came out as the second-best career of choice for students after Medicine, which was presented as the best paying top career choice. The 3rd best career choice response went to Law, which appeared to give the best freedom of time and also financially rewarding when working for yourself.

For Electrical Engineering I presented continuous development as a significant disadvantage to keep abreast with the latest industry trends including mention of the current 4th Industrial revolution, Digital Migration from Analog to Digital, Long Term Evolution (LTE) in communication and the likes. Also mentioned paying attention to detail, complying with the codes, guidelines and specifications. The other speakers who are former students of the school presented their careers in terms of their high school days, Tertiary Education and career requirements.

SAIEE banners were flying very high and were the only flyers until the architecture present at last, and they erected up their one flyer to showcase their designs. The hall was already filled by 09:30 when I arrived and immediately raised the SAIEE.

The students showed a keen interest in the services offered by SAIEE and were very well informed and were taking notes. The SAIEE support and facilities were very well received. SAIEE has made great future contact and presence in the school. Students also showed great interest, and excitedly interacted on the discussion about the fundamentals of electricity.

Present were the Parents, School Teachers, Students. Amongst the panellist was the MEC, School Principal, Architectures, Advocate, Medical Doctor, Accountant, SABC Journalist and the Banker.

CONCLUSION

The parents, as well as the students, were very interactive very excited, copying down the SAIEE email address and the website address to make a follow up as I shared the SAIEE services as well as the mentorship covering Power, Electronics, Telecommunications, Computer, Software and entrepreneurship.

A learner from the school thanked the speakers for their insight and the excellent opportunity to be informed. The School Principal Mr Qamata Khululile thanked everyone that attended the event in closing. He also highlighted the sponsorship that the school is getting from the Advocate that he will be attending to any school legal matters free of charge. A sponsor from the Banker to supply and build a Vodacom ICT centre at the school for research and experiments. A sponsor from the Architectures to design the school's building extensions free of charge. The SABC journalist handed out DVDs that have all the careers for students.

Young female scholars inspired to become engineers

As we celebrate the women of South Africa during August, the North-West University's Faculty of Engineering has once again launched its very own initiative to take these celebrations to the next level. Some 150 girls from various High Schools all over South Africa were allowed to explore the different exciting fields of Engineering during the Faculty's 4th annual Femmegineering Celebration.

According to Professor Leenta Grobler, an associate professor and strategic manager of the NWU women in the engineering programme, the days of men dominating the Engineering scene is still an evident and alarming fact. *"Despite an improvement in recent years, there remains a serious shortage of women pursuing careers in Engineering. Traditionally, this field of study remained largely unexplored by women. The North-West University aims to change this - one semester at a time."*

Over the past few years, the North-West University's Faculty of Engineering has put much focus on females in Engineering through its various initiatives. The attendees included Grade 10, 11 and 12 girls who're Maths and Science marks could enable them to study Engineering. This celebration took place at North-West University's Potchefstroom Campus.

Academic staff and senior students gave the scholars an insightful taste of the various fields of Engineering. They experienced practical experiments in chemical, mechanical, computer, industrial, electric and electronic engineering.

Tanja Gaustad, the Manager for Resource Development and Senior Computational Linguist at CTexT, gave the scholars an introduction to Human Language Technology based on the example of word prediction in language modelling and its real-world use in applications. The focus was on the diversity of tasks and techniques along with why they are interesting for someone with a more professional interest in engineering, programming and intelligent systems.

"Computational Linguistics is an interdisciplinary field of research where natural language (spoken by humans) is modelled from a computational perspective, allowing for the analysis of large amounts of data. What makes this field interesting and rewarding to me is, on the one hand, working in interdisciplinary teams with linguists, programmers and native speakers of a language, and, on the other hand, that there are still so many unsolved problems for less common languages to explore and improve," she said.

Dr Febe de Wet, yet another expert in the field of Digital Signal Processing Group at Stellenbosch University, also addressed the audience about speech-to-

text-systems. *"The people of South Africa are multilingual: the country recognises 11 official languages, and in practice, even more, are spoken. Automatic speech recognisers (speech-to-text systems) are, however, designed for monolingual input, as may be expected in many large economies such as North America, Japan or countries in Europe. In contrast, everyday South African speech often contains a mixture of languages, and such mixed language speech cannot be understood by even the best commercial speech recognisers available today. To develop a mixed-language speech recognition system, a data set of mixed-language speech is needed,"* she said. Dr de Wet is currently working on a project in which a data set containing such speech in five South African languages is being developed.

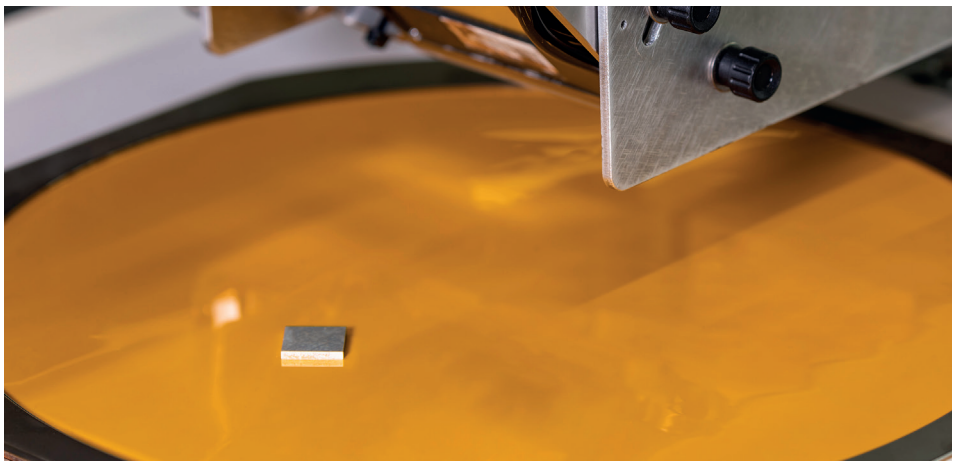
She concluded her address with an inspiring motivation for these young aspirant female engineers. *"As you would know, the field of Engineering is still being dominated by males. Don't emphasise the differences if it is not important and don't overthink it – get the work done! You don't have to fit into a stereotyped world to be successful one day. Make your story your own, and if it is different from others' stories, so be it,"* she said.

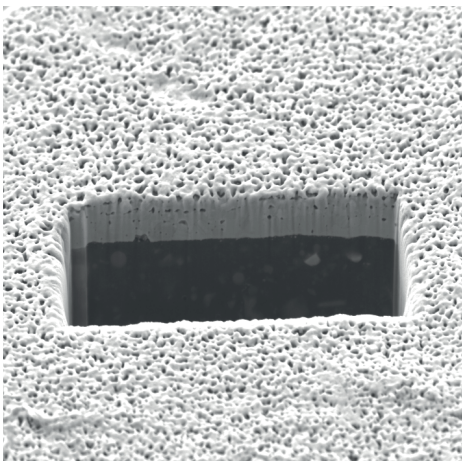
Prof Liezl van Dyk, the Executive Dean of the Faculty and an Industrial Engineer herself, also enthused these young ladies with wise words. *"I don't want to tell you to be as strong as a man; I want to encourage you to be as strong as a woman… The strength of a woman is measured by her ability to change the world for the better. I invite you to explore the exciting world of Engineering! Start dreaming of changing the world because it is within your reach. Go out and sculpt your future,"* she said.

During the event, the Faculty's second Modiragatsi competition was launched. This entails that female scholars are invited to identify a problem that we as South Africans face. They then need to take ownership of the problem and pitch a solution to address this problem. Winners will be taken on an all-inclusive trip to Silicon Valley in San Francisco where they will experience the latest developments in technology and engineering from companies like Google, Facebook, etc. and also attend the exciting Girls in Tech Catalyst Conference.

The Femmegineering event was proudly sponsored by the South African Centre for Digital Language Resources (SADiLaR) and the Manufacturing and Engineering SETA (MERSETA).

New EMI shielding technology boosts performance for 5G mobile standards





Electromagnetic interference (EMI) is increasingly becoming a challenge today – especially for new generation mobile phones and 5G technology. Heraeus now offers a new complete solution consisting of silver ink, inkjet printer and curing equipment for EMI shielding. This system is both less expensive and much more effective than all other options available today.

Electromagnetic interference can disrupt electronic devices, equipment and systems – in consumer electronics like mobile phones but also in automotive, medical or aerospace electronics. With higher performances of today's electronics and new 5G technology, EMI shielding becomes more and more important to have working devices. As frequencies increase, so is the amount of electromagnetic interference.

To tackle this problem Heraeus developed a new solution, which is based on a silver ink printer that ensures a proper functioning of high-frequency on-board chips and their ultra-fast data transmission. The system consists of a special silver ink formula and a manufacturing machine that can apply the shielding coating followed by special ultraviolet and infrared equipment for curing.

"In a 5G world, the Heraeus EMI Shielding Solution is the most cost- effective answer for technology that is going faster, higher and further every day," says Franz Vollmann, Head of Heraeus Printed Electronics.

BETTER SHIELDING WITH LESS INVESTMENT

Heraeus' new EMI shielding technology saves considerable costs and effort in comparison to traditional shielding technologies like metal housings or vacuum-based sputtering.

In contrast to sputtering, the protective silver layer is applied to the carrier object with sub-micrometer precision by using printing nozzles.

"Our new EMI Shielding Solution will replace sputtering technology. It not only saves material and costs, but it also leads to a much better shielding performance. This is necessary for further miniaturization," says Franz Vollmann, Head of Heraeus Printed Electronics.

Silver inkjet-printing also offers further decisive advantages over sputtering in terms of cost and efficiency. The investment cost for the new Heraeus system is around US $500,000 (depending on the machine configuration), which is a fraction of the price of a sputtering system. At the same time, the number of units able to be produced per hour is between 12,000 and 15,000 – more than three times the output from a sputtering system.

"Adding the saved investment, our inkjet process is 15 times better at one million parts per year," explains Vollmann.

LINKING INNOVATION

Previous inkjet solutions often failed due to unsuitable inks, which irreparably clog the printheads. The Heraeus advantage lies in its innovative ink molecular structure: Based on Metal Organic Decomposition (MOD), the silver components are not individual ink nanoparticles, but linked elements of organic molecular chains.

After being applied, the organic parts evaporate through the application of heat – only the silver remains. In this way, the heads remain unclogged by individual particles, which saves considerable costs and effort.

Dehndetect Keeps you informed and Protects Wind Turbines from Failure

Lightning damage frequently remains undetected in wind turbines, as it often does not lead to the immediate failure of the system. Upward lightning – or ground-to-cloud lightning - with an initial long stroke current of only a few hundred A is the chief cause of damage such as melting on the receptors of the rotor blades. In the long term, this damage can lead to turbine failure.

Florian Vögerl, head of sales and operations at DEHN Africa, says, "Due to the low current flow of upward lightning, standard measuring systems frequently fail to detect this form of lightning. DEHNdetect is a lightning current measuring system for detecting lightning events. It has been designed to register these long stroke currents on wind turbines, as well as impulse current, in order to prevent the need for expensive maintenance work and long downtimes. DEHNdetect can also be equipped with optional rotor blade detection."

The system can be integrated into the IT infrastructure of the wind turbine via existing interfaces. The data can then be read out and managed using the available SCADA systems. If direct integration is not possible, the data can be transmitted to a cloud system and evaluated via a web application. This makes it possible to monitor several turbines or even entire wind parks.

DEHNdetect identifies the following parameters:

- Impulse current [kA]
- Long stroke current [A]
- Load [C]
- Specific energy [MJ/Ω]
- Rise time [kA/µs]

"DEHNdetect identifies the affected rotor and notifies you in the SCADA system or online," clarifies Vögerl. "The benefits include always being up-to-date with the system, being able to prevent subsequent damage, having lower maintenance and repair costs, and experiencing less downtime."

"DEHNdetect keeps you informed about what is going in your wind turbines, whether for an individual turbine or an entire wind park, giving you continual data on the condition of your components. This includes the option of setting up push messages to be sent directly to your smartphone or tablet. The system allows you to invest in availability and make your wind turbines a reliable source of power, both now and in the future," he concludes. wn

INDUSTRY AFFAIRS

Regulating Efficiency In Motors Can Help Stablilise South Africa's Power Supply

Regulating motor efficiency will help stabilise South Africa's power supply

South Africa could go a long way to cut the risk of future load-shedding by adopting a minimum efficiency performance standard (MEPS) for electric motors.

According to Fanie Steyn, manager rotating machines at Zest WEG Group, a MEPS would significantly reduce the peak power demand on the national grid. Importantly, the step could be made at no cost to government and would also bring substantial savings to industry's electrical energy costs.

"The MEPS would phase out the least-efficient electric motor classes by setting a minimum standard for the efficiency of motors imported and sold in South Africa," he says. *"The essential challenge now is that about 280,000 electric motors are imported each year, many of which are low efficiency motors rated at IE1 level as standard."*

Steyn highlights the great strides recently achieved in the efficiency of electric motors. Energy savings of between 2,1% and 12,4%, depending on the individual power rating, can be made by converting from a standard efficiency IE1 motor to a premium efficiency IE3 motor. The capital cost differential is slight and is quickly recouped by lower operating costs.

"It is estimated that as much as 30% of all energy produced globally is consumed by electric motors," he says. *"It is therefore easy to see why improving motor efficiencies has a huge impact on national energy consumption."*

It is significant that more than 42 countries already have MEPS in place. These standards apply mostly to three-phase low voltage motors from 0,75 kW to 375 kW capacity. The MEPS is applied at import stage, so the process would be handled in the conventional manner by customs agencies.

"If the 150,000 low voltage motors entering the country each year were IE3 rated instead of IE1, the national grid could be relieved of about 195 million kWh in a single year," says Steyn. *"This means almost three billion kWh over the next five years."*

He adds that this would also mean lower carbon emissions from power stations. South Africa has committed to reduce these emissions by signing the Paris Agreement in 2016.

"Implementing MEPS will have significant benefits for everyone," Steyn concludes.

Ultra Stable Oil-Dielectric RF Termination Loads

For maximum process repeatability and consistency, modern plasma applications require precise RF power regulation and control. A key component in ensuring accurate and repeatable RF power delivery to the chamber is calibration, regulation & monitoring of the RF generator.

COMTEST local representative of Bird Technologies, provider of RF components, subsystems and test equipment - now offers ultra-stable, low VSWR (voltage standing wave ratio) loads for quick and precise measurement of generator power output when used with precision power sensors

New integrated earth leakage protection technology for circuit breaker ranges

Schneider Electric has announced the introduction of integrated earth leakage protection for its Compact NSX & NSXm moulded circuit breaker ranges.

"The award-winning Compact NSX moulded case circuit breaker range and the new, smaller Compact NSXm range, now both feature integrated earth leakage protection, Micrologic Vigi," explains Maphuti Levy Mohlola, Offer Manager at Schneider Electric South Africa.

"This is a technology that monitors the flow of current and sends pre-alarms in the event of earth leakage, interrupting the circuit instantly, should it detect any organic disruptions, effectively preventing the danger of electric shocks.

"This innovation means that during the process of installing circuit breakers, panel builders and contractors are no longer required to install an additional earth leakage module, which can lead to savings of up to 40% in installation time. Because the ranges have integrated earth leakage protection, the same frame size as a standard breaker, they are designed to conveniently fit in the same row."

ECOSTRUXURE POWER CONNECTIVITY

The ranges are part of the Connected Products portfolio of the Schneider Electric IoT enabled architecture, EcoStruxure Power, an open, interoperable, IoT-enabled system architecture and platform. It delivers enhanced value around safety, reliability, efficiency, sustainability, and connectivity for its customers.

EcoStruxure leverages advancements in IoT, mobility, sensing, cloud, analytics, and cybersecurity to deliver innovation at every level. This includes connected products, edge control, and apps, analytics & services. EcoStruxure has been deployed in 480 000+ sites, with the support of 20 000+ system integrators and developers, connecting over 1.6 million assets under management through 40+ digital services.

RELIABILITY THAT FITS

"Designed with high-breaking capacities for all standard and specific applications, and with an operating current up to 630A, the Compact NSX circuit breaker range features integrated earth leakage protection, and offers local and remote communication with trip alarm and pre-alarms for proactive operational and energy efficiency," continues Mohlola.

"The range provides corrective, preventative and predictive maintenance and energy management to enable potential savings, and ensure customer installations can be optimised, in terms of performance and protection."

EFFICIENCY THAT CLICKS

"As the newcomer to the range, for applications up to 160A, the Compact NSXm range is designed for low-voltage panel boards and control panels. As the smallest frame size in the Compact NSX range, and similarly featuring integrated earth leakage protection, it is an ideal space-saving solution for installations.

"This efficient solution offers a flexible installation, thanks to a built-in DIN rail and plate mount capability, while field-installable options such as rotary handles and one-click auxiliaries make it easy to configure the circuit breaker to the user's specific needs. The Compact NSXm range also features EverLink creep-compensating technology. This patented technology ensures a lasting connection by mitigating the loosening effects of heat cycling or vibration."

INCREASED EFFICIENCY

"There is more pressure than ever on panel builders and contractors to come up with time and cost saving solutions during the process of efficient mounting, installing and cabling of switchboards for their customers.

"As leaders in the digital transformation of energy management and automation, we recognise that our partners demand innovations that offer efficiency, reliability and connectivity. We are responding to this need with integrated earth leakage protection technology, all of which means that Compact NSX and NSXm circuit breakers are easier than ever to install – and in some cases, help to make installation time up to 40% faster," concludes Mohlola.

such as the Bird 4020 series. Bird models 8865SC13, 8890-300SC13, 8921SC13 and 8931 SC models not only provide low VSWR but also less than 0.1 dB total change in VSWR at process critical frequencies. There is no need for load warm-up or risk of repeatability due to calibration for different lengths of time. This can minimize the errors associated with this calibration and control one of the more critical process variables. Contact COMTEST for more information on the Bird 4020 series of precision power sensors on 010 595 1821 or sales@comtest.co.za

ST -TALKS

The IEC 62305 (2010) standards and their South African adaptations comprehensively describe the implementation of lightning protection systems for buildings and many other structures. However, the recent studies in Asia and Africa reveal that design and construction complexities, cost and material theft prevent many building owners, and even government authorities, from adopting such recommended practices, especially for small structures.

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FSAIEE

Apart from domestic applications, many outdoor activities such as sports and recreation, mining and construction etc., require either stand-alone protection units or low-cost, easy to implement lightning protection units for temporary shelters and small houses, especially in regions with high lightning occurrence.

This paper addresses this issue, specifically in the African continent where annual lightning-related injuries are overwhelmingly high.

INTRODUCTION

Although, the protection of buildings is well-documented in many international and local standards, several factors prevent a significant percentage of the global community from implementing such systems for all small structures, especially in the developing countries, despite the need.

These factors include the complexities of design and implementation of the protection systems, cost, aesthetic concerns, material

Lightning Safety Structures for Applications in the Industrial sector and Under-privileged Communities in Africa

theft and some socio-cultural aspects. The need for such protection measures is also experienced in outdoor activities such as sports, entertainment and recreation, the livestock industry, mining and construction industries, inland fisheries, pilgrimaging and adventure excursions, etc.

Under such a backdrop, stand-alone protection units, or low-cost, easy to implement lightning protection units for shelters are essential needs in countries with high lightning occurrence.

LIGHTNING THREATS IN DEVELOPING COUNTRIES

Lightning currents are impulsive in nature and last for few tens to few hundred microseconds [1]. Most often, a single lightning flash produces multiple impulse currents which are termed subsequent strokes. Their amplitude ranges from a few kilo Amperes to a few hundred kilo Amperes [1]. Defined by the wave shape there are three types of lightning currents; negative first stroke, negative subsequent stroke and positive stroke [1]. Any lightning safety/protection device should be tested for all three types of lightning currents as they have features unique to each of them.

A person is safe only inside a sturdily built structure enclosed with a system of metallic strips. IEC 62305 (2010) [2] and its national counterparts all over the world give a comprehensive account on how to develop a lightning protection system for a given structure. The output of research presented in [3] and [4] emphasizes the gravity of lightning risk to public in low-

Lightning Safety for Structures

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income societies that earn their living by outdoor activities. Industries such as mining, timber and petrochemical urgently require suitable protective shelters for their outdoor workers operating in high lightning occurrence regions [personal communication with experts in the respective fields]. In this backdrop, Gomes et al [5] provided design and implementation techniques for implementing low-cost lightning protection schemes for existing house and boat structures in low-income societies. They also suggested improvement of lightning protection in buildings with a reinforced steel structure at a very competitive cost [6].

At present it is not normal to expect the public to take shelter inside such sturdy protected buildings while a thunderstorm lasts, which may be 1-2 hours. Many studies conducted in Africa, Asia and Latin America in the recent past reveal that a majority of the public in these parts of the world reside permanently in very unsafe simple structures that may expose the occupants to a grave risk of being injured in the event of a lightning strike [4, 7-11]. Figure-1 shows a site of a lightning damaged house in Zambia [4] which demonstrates the high vulnerability of small unprotected structures to this extreme atmospheric event.

Work done in Mongolia [7] reveals that almost 90% of the lightning accidents in the country occur in cases where victims were in 'wild areas'. These 'wild areas' are referred to grasslands or areas with low growing vegetation on the mountain slopes where shepherds graze their livestock. These landscapes, very similar to the Savannahs in Africa, are many hundred hectares in area, thus the workers in the livestock industry that lead the animals have no place to take shelter even if they are warned well in advance of a thunderstorm. Similar observations have been made in Uganda, where people in the Lake Victoria Basin are compelled, for economic reasons, to go fishing even under overcast conditions [3]. In the event of an approaching thunderstorm, they are at the mercy of nature as it is almost impossible to abandon their operations abruptly and travel to the shore, which may be a couple of hours journey. In such a scenario, providing early warning to the boaters may not be as effective as one anticipates. Thus, the only option is to fit a certain level of protection to their boats at an affordable cost.

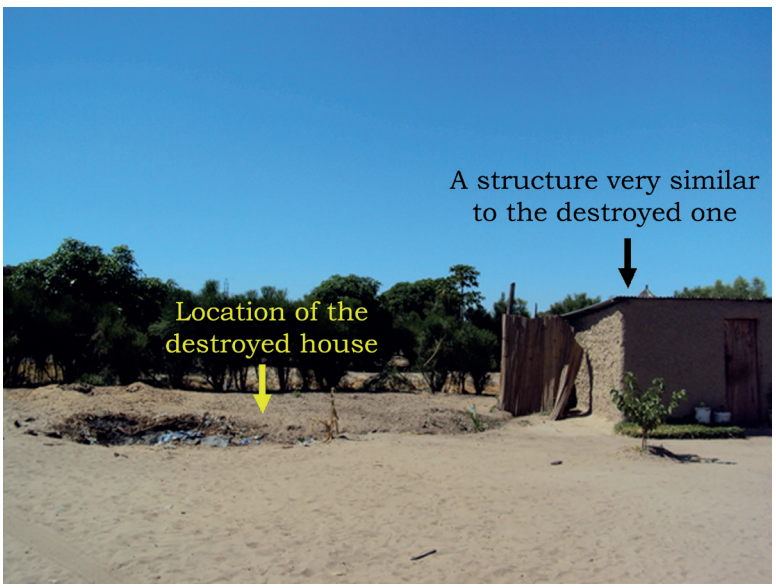

Figure 1

Even in developed countries, there are many lightning accidents reported where the victims were campers, golfers, adventure-seekers, boaters etc., who could not access a safe shelter in time after they have detected an approaching thunderstorm [12, 13].

LIGHTNING SAFETY MEASURES FOR AFRICA

The above background demands more feasible and practical solutions to address the lighting safety issue, rather than requiring the public to seek shelter in sturdy structures whenever there is a thunderstorm in the vicinity. There are several mechanisms by which lightning may affect human beings and animals. These primary and secondary mechanisms are listed below [14-15]: -

1. Direct strikes: A person in open field protruding above the surrounding area may be the subject of a direct lightning strike if the answering upward leader from the person meets lightning stepped leader.
2. Side flashes: A person close to a tall object may receive a side flash if the tall object is hit by lightning. In such case either the entire lightning current or a part of it may pass through the victim's body.
3. Step potential: When the feet of a person are separated in the direction of increasing potential, a partial current may pass through the body due to the lightning strike injection of current into earth.
4. Touch potential: A partial current may pass through the body of a person, if a part of their body comes into contact with an object that is at a high potential from a nearby lightning strike while another part of their body is in contact with the ground.

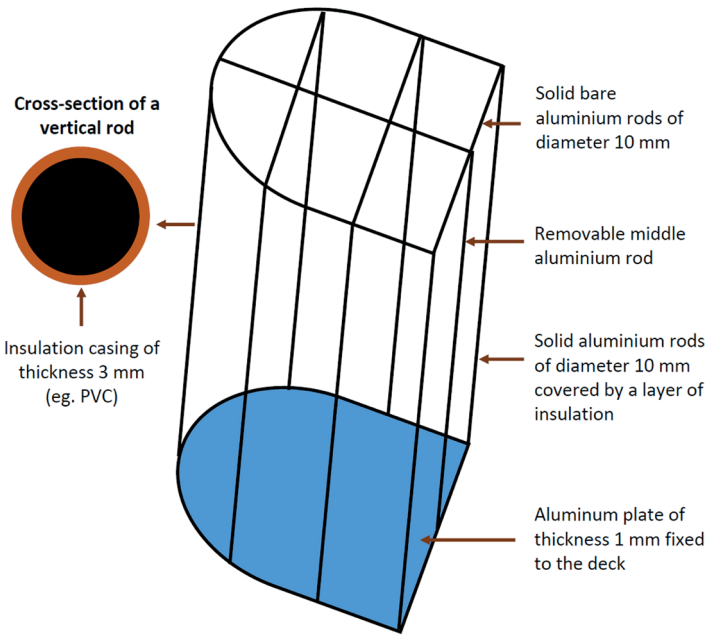

Figure 2

5. Upward Streamers: As the lightning stepped leader reaches ground from the cloud, typically carrying negative charge, it creates an intensive electric field in the vicinity. Hence, many objects, including people in the surrounding area start sending oppositely charged streamers towards the stepped leader. Once one of those answering leaders becomes successful in meeting the stepped leader, the others collapse. These collapsing answering leaders give rise to a sizable current through the body of the objects that send them. Such currents may often paralyze a person; however, depending on the parts of the body that it passes through, serious injuries or even cardiac failure may result.
6. Proximity to the strike: The shock wave generated by lightning channel due to sudden expansion of air may damage the skin or ear drums when the person is very close to the point of a strike. Furthermore, the intense light may cause vision impairment of people or animals close by.
7. Secondary effects: Other effects include, falling from height due to momentary shock, falling of heavy materials from structures (detached due to the lightning strike), falling of tree branches and penetration of splinters from exploding tree barks, burns and choking hazards due to volatile materials in the surrounding area catching fire, shockwave from exploding substances, and psychological trauma.

The protection measures adopted should prevent the protected person from most of these injury mechanisms. However, it is not that easy to develop a structure that safeguards the occupant from all seven mechanisms, especially the 6th and 7th. In these cases, the only way to minimize the hazards is to educate the public on taking necessary precautions, such as wearing ear plugs and dark glasses, while seeking shelter inside the safety structure and to pay attention to the environment where the protective structure is located.

There are three types of protective measures that can be recommended for a high lightning occurrence region, based on the target group that needs protection.

1. Easily and readily implementable structures for individuals or small groups that may caught up in thunderstorms during outdoor activities (golfers, hikers, adventurers on jungle, dessert or field tracking etc.).
2. Permanent purpose-made protective structures placed at places of mass outdoor activities (construction sites, mining sites, agricultural fields, grounds or open spaces where people gather for religious, cultural or political activities etc.).
3. Small dwellings that are used by people as their permanent living space or home.

Wiesinger [16], Darveniza et al. [17] and Darveniza [18], developed concepts of portable lightning safety devices for individual or small group usage, few of which have been tested under laboratory conditions. However, lack of theoretical approach through simulation and/or computation, testing with human body models and the consequent retirement of the sole project leader from active research prevented the device being developed to a level of wide scientific acceptance.

The concept proposed by the publications [16-18] have been reconsidered and further developed at the University of Witwatersrand's lightning protection research group under the Eskom Power Plant Engineering Institute-HVAC (Wits Group), at present. The diagrams of a protective structure for a small group developed by the Wits Group is schematically demonstrated in Figure 2. The structure can be carried in a dual-purpose vehicle, such as a pickup truck, and erected at

Lightning Safety for Structures

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a place of lightning risk. It is ideal for sightseeing location viewpoints, decks of open boats, golf courses (for spectators) etc. The Figure 3 shows the preliminary version of an individual lightning protection structure developed by the Wits group, which is ready for testing. Using simulations, all structures developed by the Wits Group will first be shown to be effective, and also optimized for materials used. Then they will be tested under HV current and voltage impulses. They will also be tested with triggered lightning before being commercialized.

Another attempt to develop such personal protection systems has vaguely been revealed by Prof. Liew Ah Choy of National University Singapore in 2009. During an interview with the Star Newspaper [19], he mentioned that plans are underway to develop a fabric which while covering a person or group of people could safely dissipate the lightning current into the ground. However, no further information on this device is available in the public domain so far.

The Wits Group has also developed a future concept for an individual lightning protection kit, which could be used by people who attend specialized tasks under thunderstorm conditions, such as linesmen, technical and mechanical personnel that attend emergency outdoor repair work, investigators of extreme weather events, hikers, sailors on open yachts (under unexpected thunderstorm conditions), etc. The simulation studies of both individual structures and the lightning protection kit are completed and now the safety devices will be tested with 10/350 μs impulse current. Figure 4 depicts the components of the proposed lightning safety attire. All devices will be tested for their ability to prevent the first five injury mechanisms under high amplitude and high energy lightning strikes.

Several incidents are reported in South Asia, Africa and Latin America, where a large number of people are injured (and a vast majority of the victims succumb to their injuries) due to a single lightning flash that strikes the structure that they have occupied [20]. In most of these cases the people have gathered inside unprotected structures to seek shelter from rain. These structures are most often prayer houses close to agricultural fields, construction sites etc. Incidents were also reported in purpose made churches as well.

Figure 3

The only way of protecting a permanent structure with large area span is to provide it with a lightning protection system as per the recommendations set forth in IEC 62305-3 (2010) [2]. In such cases, the best cost-effective option is to protect one large structure and advise the public to gather inside that protected structure. At present a project is being conducted in Uganda, under the leadership of ACLENet, in protecting schools in highly lightning occurrence areas [21]. To minimize the cost and theft of material we recommend that aluminium or galvanized iron be used as the air-termination and ground conductors of such buildings. A ring conductor (Type B grounding system as per the IEC 62305-3), is strongly recommended for the earthing system of the structure to prevent step potential hazards to the occupants.

Gomes et al [5] proposed discarded cargo containers to be modified as lightning safety structures, which can be permanently placed at unprotected locations. The cargo container with entrance and ventilation would be a faraday-cage like structure that will give a very high level of

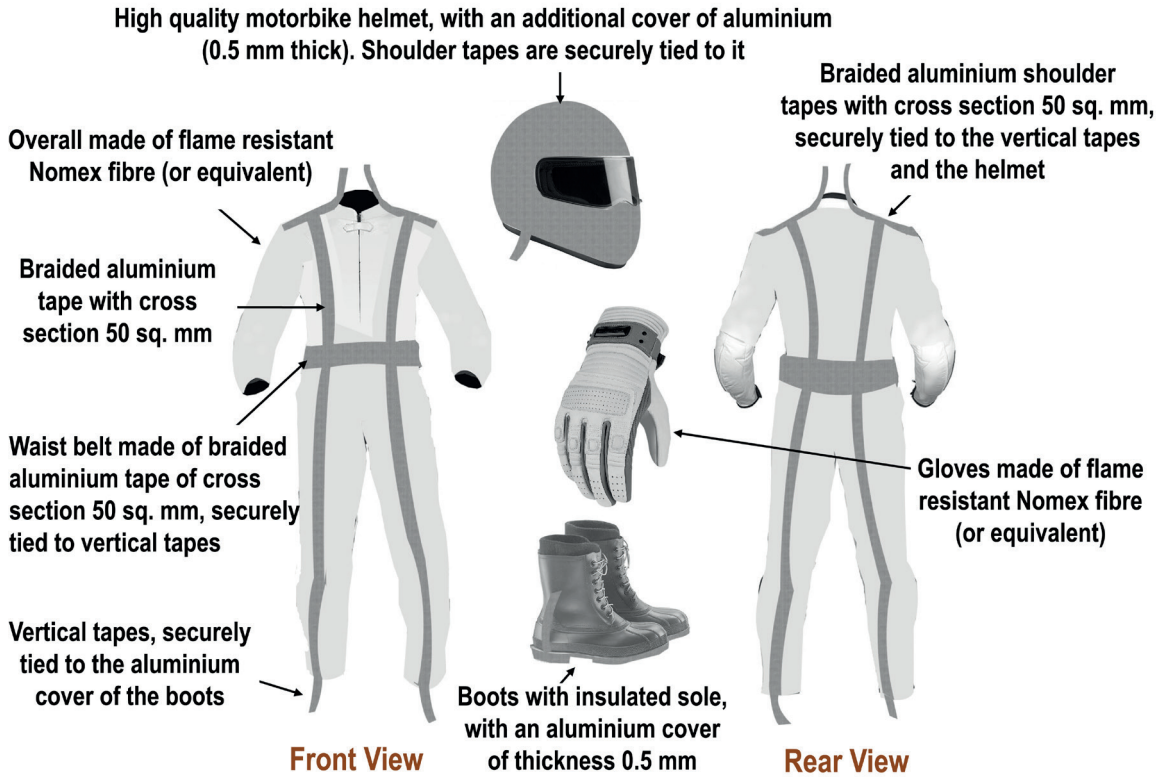


Figure 4

protection to the occupants. If we consider only the safety of the occupants (inside the structure) the system does not need a purpose made earthing system. However, if there are concerns of minimizing the step potential risk to people that may approach the structure at the time of strike, it is recommended to ground the container body, at least at the four sides to achieve a ground resistance of less than 10 Ω. Figure 5 shows such a structure.

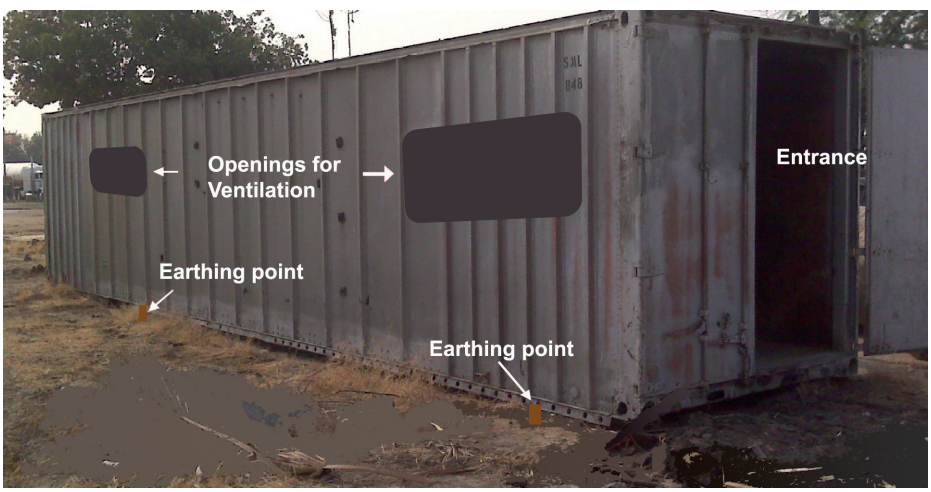


Figure 5

The observations made in South Africa [22] and USA [23, 24] reveal that in the recreational sector, permanently built protective structures for groups or protection schemes for already built small structures are practically more viable than portable devices due to the added burden

Lightning Safety for Structures

continues from page 23

of having to carry and set up personal protective structures. Another advantage of the permanent structures is the opportunity for the designer to propose a comprehensive earthing system which could prevent step potential hazards for the approaching people. This is extremely important in the case of places where the public are mostly one-time visitors (amusement and leisure parks, beaches, playgrounds etc.). In the cases of outdoor workplaces such as construction and mining sites, the workers could regularly be made aware (or strict guidelines could be set forth) to occupy the safety structures well in time.

The research conducted by Mary and Gomes [8] in Africa, Doljinsuren and Gomes [7] in Minor Asia, Jayaratne and Gomes [25] in South Asia reveals that in under-privileged societies, protection schemes for small structures are more appropriate than personal lightning protection devices or a large single protected structure for the community. This is specifically important in the case of societies that have houses sparsely distributed in a given area. In such cases, the population may not be able to gather in a central protected structure due to several strategic and societal reasons.

The most challenging task of providing protection measures to a large number of small structures in a community is the prohibitively high cumulative cost incurred. Gomes et al [5] proposed cost-effective solutions to this issue. They proposed two aluminium or Galvanized Iron (GI) poles interconnected at the top by a catenary wire as the air termination and a ring conductor to encircle the structure (Figure 6). The two poles and catenary wire cost less than very tall mast which needs special attention to ensure its stability. The vertical earth rods are optional and as with the ring conductor one could be relieved of achieving very low earth resistance.

As far as the occupants are concerned the step potential inside the structure will be below injury level, as per the ongoing simulations done by the Wits Group. Furthermore, in most of the cases of these structures (almost all), the criteria set forth in IEC 62305-3 (2010) [2] for type B, is satisfied by the ring conductor itself, if it is totally buried along its length. Thus, there is no need for achieving a limiting earth resistance, except for the case that the safety of people approaching the structure is of importance. In the worst scenario (with

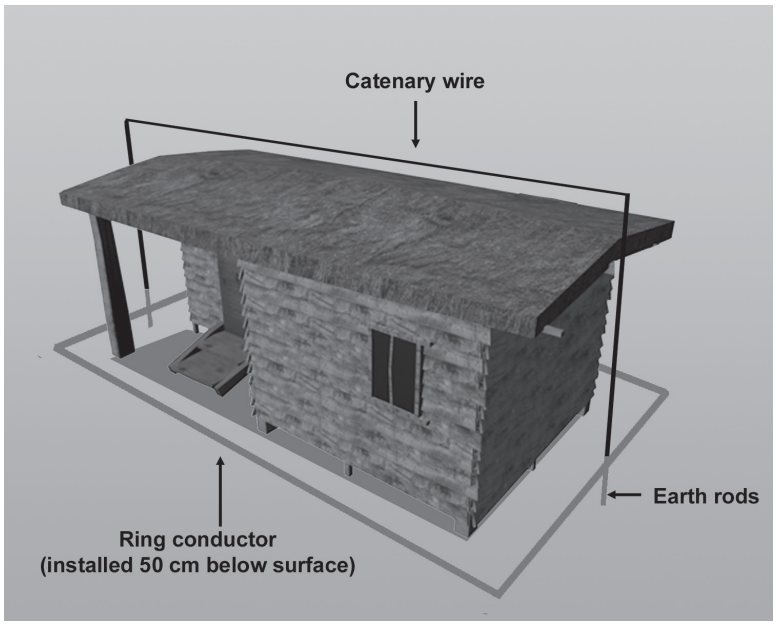


Figure 6

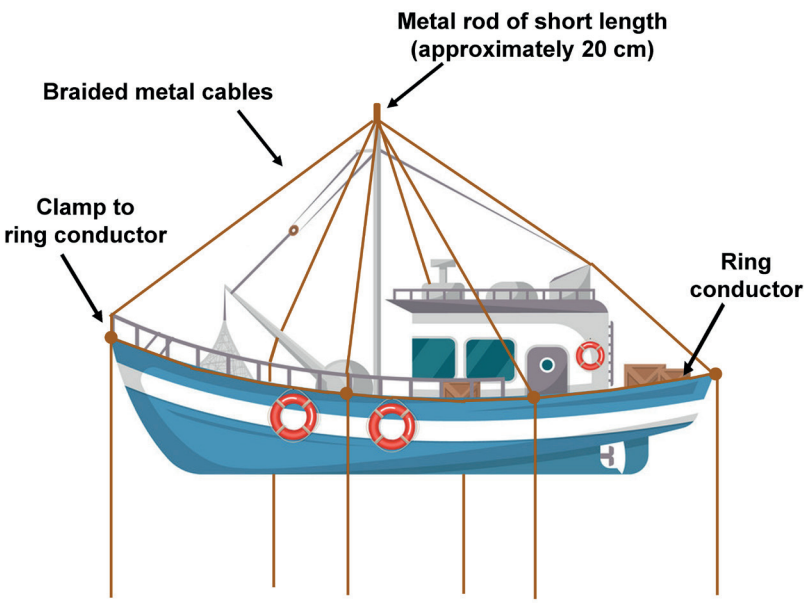
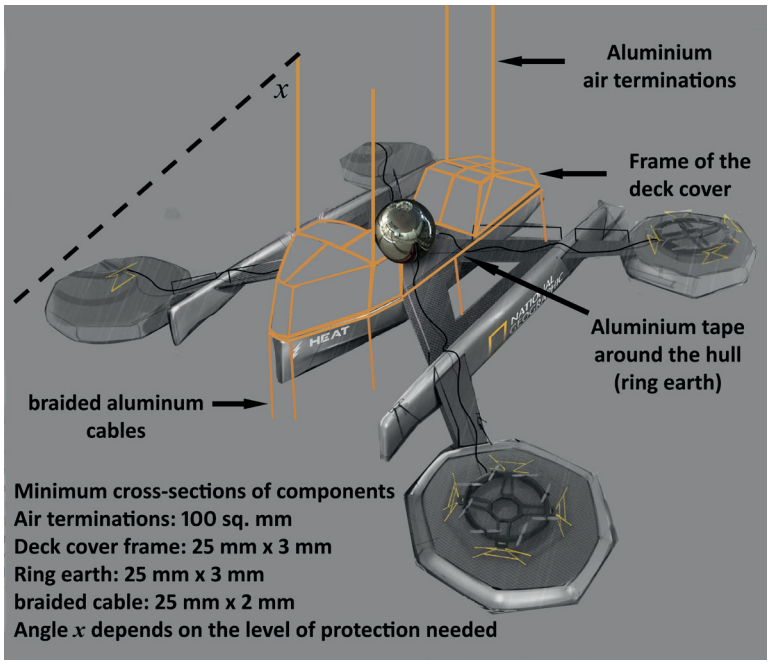


Figure 7



respect to the cost constraints), use of steel reinforcement bars of at least 10 mm diameter could be used to implement the ring conductor. In considering the clearance of the catenary wire and the poles from the protected structure, the sagging and natural inclinations should be considered. The computational method has been described in IEC 62305-3 (2010) [2]. It is recommended to specify approximate values for the clearance distance for a typical housing structure, as a rule of thumb.

In the cases of protection measures described in Figure 6, one should pay attention to the threats posed by the animals (monkeys, baboons and large rodents etc.) on the mechanical stability of the air-termination. This issue has not yet been taken into account in the studies done so far. In cases where the catenary wire is too troublesome, it can be eliminated by increasing the height of the poles appropriately.

Gomes et al [5] have also suggested a solution to boating communities, especially those who are in the fishing industry, to protect against lightning in the event that they are caught up in a thunderstorm while fishing in deep waters. The Figure 7 shows a schematic diagram of this solution.

A collection of metal strands possibly braided aluminium cables are fixed into a purpose installed short metal rod at the highest elevation of the boat. They could be bundled and kept aside under fair-weather conditions. In the event of an approaching thunderstorm they could be spread over the boat as it is shown in the diagram. Each strand is clamped to a metal cable/strip that is permanently fixed to the hull of the boat. The ends of the metal strands are then placed into the water so that they are submerged up to about one meter deep. The occupants of the boat should keep a safe distance away from the braided metal cables once they are deployed in the lightning protection position. This design is also under the investigation (simulation and HV testing) for material and design optimization by the Wits Group.

Replacing bare metal cables by insulated cables is also under investigation. Such replacement could reduce the minimum separation from the cables to a much smaller value. Figure 8 illustrates the lightning protection system designed by the author for a no-occupant vessel that carries recording instruments and drones on a thunderstorm exploration mission by National Geographic Channel (NatGeo). Note that in such cases the required level of protection may be reduced due to the absence of human beings.

CONCLUSIONS

This paper discusses the need for lightning protection systems for small structures in Africa and other developing countries and the way forward for the design, testing and implementation of such systems. The paper also emphasizes the requirements to be fulfilled by both designers and manufacturers to ensure safety and socio-economic acceptance.

The need for such protection structures is enormous, however, the challenges and barriers to making such a venture successful, in both business and social welfare points of view, are also colossal. A well planned and strategic, collective effort is required from scientists, business community and governmental / non-governmental sectors to make the objectives of such a project reach the desired milestones and goals.

ACKNOWLEDGMENT

The author would like to thank the Wits Group involved with lightning and high voltage research and the staff of the Faculty of Engineering and the Built Environment for their support in making this work a success.

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ST -TALKS

Lightning Protection Innovation for Thatch Structures

Thatch buildings located in high lightning flash zones always have required protection from lightning. The risk of fire as a result of a direct lightning strike and the consequent destruction of the thatch structure is too high.

BY I TREVOR MANAS
DIRECTOR
LIGHTNING PROTECTION CONCEPTS

The resultant financial costs of the destruction of a thatch structure often into the tens if not hundreds of millions of Rands per event. The loss in human life and the loss of irreplaceable items, however, cannot be calculated.

WHEN IS A LIGHTNING PROTECTION SYSTEM (LPS) NEEDED?

To determine whether an LPS is required for any structure, the lightning protection risk assessment process following SANS 62305 Part 2 must be carried out.

In the determination of the risk levels for thatch structures, two key factors have a significant impact on the calculated risk, namely:

- high risk of fire
- the lightning flash density of the location

All thatch structures inherently have a high risk of fire even if the thatching is equipped with a fire retardant covering, it is, therefore, the location of the thatch structure that determines whether an LPS is required or not.

Having conducted much thatch LPS risk assessments for over ten years, we have found that any thatch structure located in any area with a lightning flash index of 4 strikes/km^2/year or higher requires the installation of an LPS.

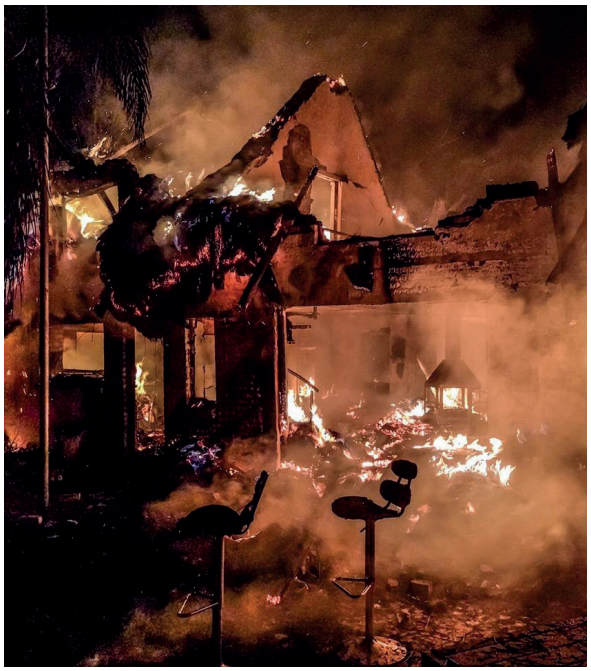
The carrying out of the lightning protection risk assessment following SANS 62305 Part 2 is mandatory and must be conducted for all thatch structures no matter in which lightning zone the structure is situated.

FREQUENCY OF LIGHTNING IN SOUTH AFRICA

There is no doubt that vast areas within South Africa can be regarded as 'high lightning' zones when considering the risk of damage or losses to thatch structures.

It is also evident that there has been a vast increase in the number of lightning occurrences in South Africa over the past 10 to 15 years.

As per the data shown below, the following are the lightning flash indexes for Johannesburg since 2010:



Lightning Protection for Thatch Structures

continues from page 29

2010 - Johannesburg: 7.5 strikes/km²/year (SANS 103 13:2010)
2012 - Johannesburg: 11.7 strikes/km²/year (SANS 10313:2012)
2018 - Johannesburg: 13.4 strikes/km²/year (SANS 10313:2018 - preview standard, to be published)

As can be seen, there has been an almost 50% increase in the amount of lightning in Johannesburg. The same applies to most areas of South Africa. This means that there are vast areas where the risk of lightning damage has exponentially increased from an LPS not being required to an LPS being needed as per the lightning risk assessment process.

It is also unfortunate that most of the owners of thatch structures located in previously border-line lightning zones are unaware of the increased levels of risk to their properties.

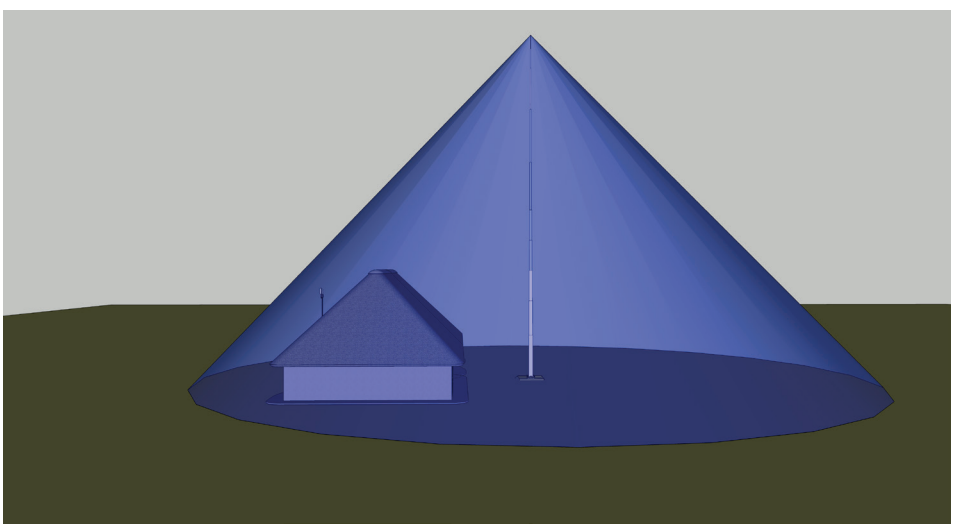
CONVENTIONAL LIGHTNING PROTECTION MEASURES

Traditionally, conventional lightning protection methods like the use of free-standing masts have been employed to protect these potentially highly flammable structures.

Free-standing mast protection methods are undoubtedly unsightly and often severely detract from the buildings aesthetics, primarily when the thatch structure is located in an area of natural beauty.

Free-standing masts are installed away from the thatch structure, to isolate the LPS from the structure. Typically, free-standing masts are installed with a minimum separation distance of 1m away from the thatch structures.

Conventional Masts



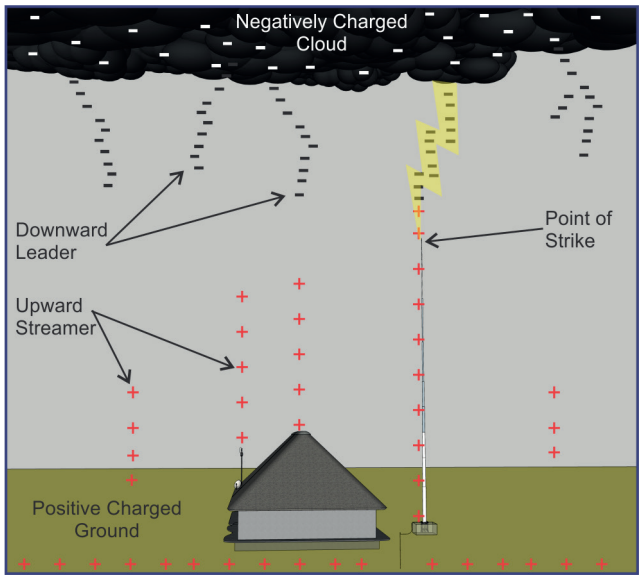
In order to provide the correct lightning protection zones over the entire thatch roof, free-standing masts must be very tall, ranging between 15m and 30m in height.

DISADVANTAGES OF CONVENTIONAL LPSS

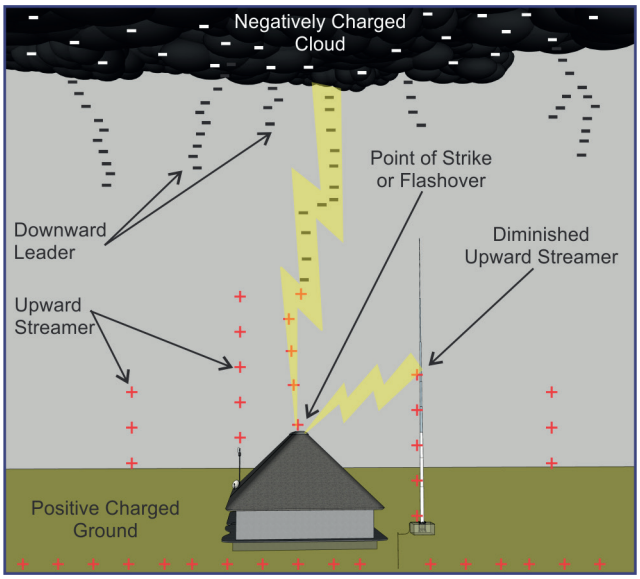
Besides being aesthetically unpleasing, free-standing masts pose a significant step and touch potential hazard, especially when they are installed in public or high traffic areas.

It has also been found that many free-standing masts are very old and have not been adequately maintained during their life span. Ageing of or lack of maintenance of free-standing masts can be more dangerous than no protection at all.

Old free-standing masts can lose their electrical continuity from the tip of the mast to the base of the mast at the connection to the mast earth termination system. This affects the free-standing mast's ability to be the preferred point of strike. The lack



Fully functional freestanding Mast.



Malfunctioning freestanding mast lack of maintenance/age.

of continuity across the mast can result in flashovers to lower paths of resistance to earth, such as the structures electrical system. These flashovers cause dangerous sparking and can result in an ignition of the thatching. Dangerous flashovers can also occur when the mast earth termination system has corroded and is no longer functional.

Free-standing masts are challenging to maintain because, in order to verify whether the mast is electrically continuous across its length, the mast must be lowered to gain access to the top of the mast.

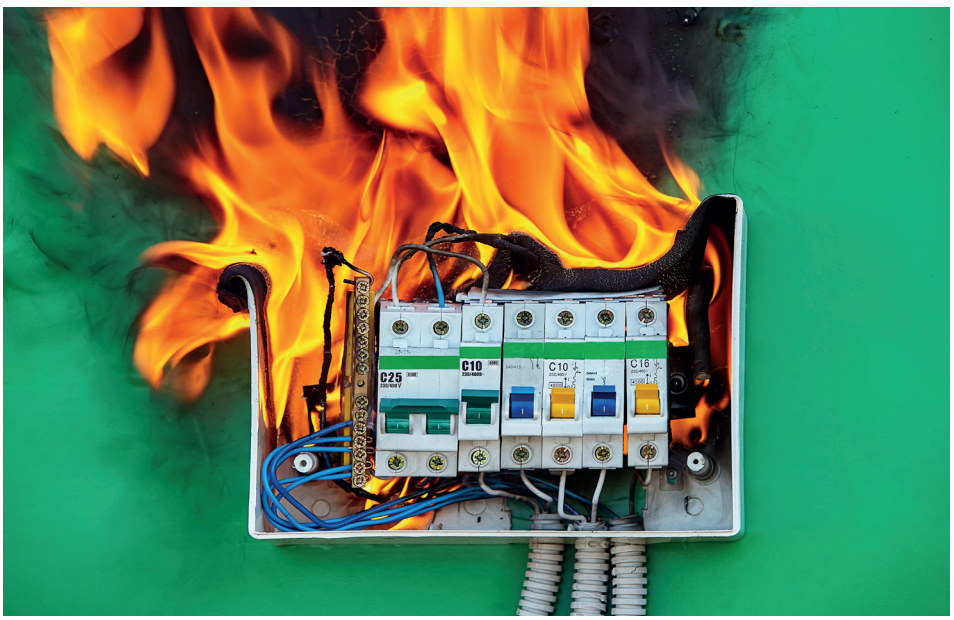
Specialist earthing and LPS inspectors make use of drone technology to gain access to the top of the mast to carry out the required continuity tests. The carrying out of earth resistance tests do not thoroughly verify the functionality of a free-standing mast, the confirmation of an electrically continuous free-standing mast is critical in certifying the LPS installation.

DAMAGE TO ELECTRICAL SYSTEMS

Recent research has also shown that these conventional LPSs have also proven to present other lightning associated problems with nearly half of all thatch owners reporting the damage to electrical equipment inside the structure.

91% of all thatch owners that were surveyed do not have the proper surge protection systems for the electrical/ electronic equipment.

The provision of lightning current arresters and surge arresters to electrical equipment inside thatch structures is imperative.



Lightning Protection for Thatch Structures

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HVI® PROTECTION MEASURES

HVI® protection systems have been installed in South Africa since 2013 to various types of structures that require the provision of an isolated LPS. Many of these HVI® installations were for the protection of explosive and highly flammable structures.

The HVI® technology allows for the installation of the HVI® air termination masts directly onto thatch roofs. This means that a much lower HVI® mast installed directly onto a thatch roof provides the same zones of protection as a very tall free-standing mast.

HVI® PROTECTION OF THATCH STRUCTURES

The use of HVI® conductors enables the installation of an 'Isolated Lightning Protection System' that is architecturally appealing and more cost-effective.

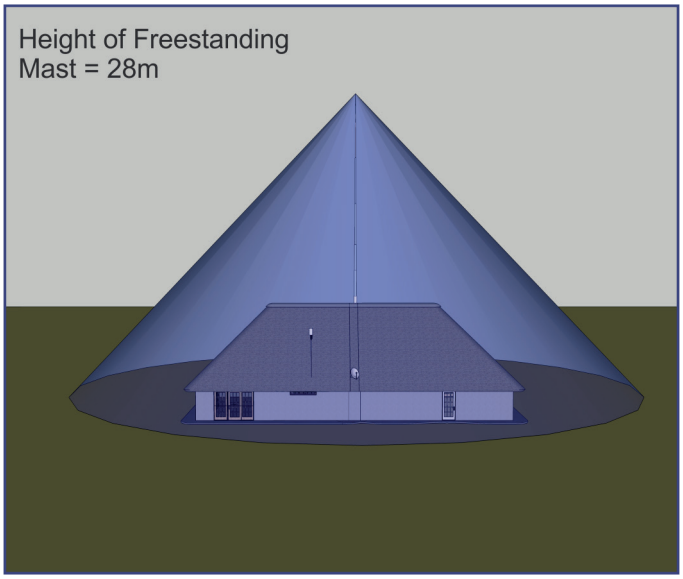
The lightning protection system must be designed according to the requirements of a lightning protection level 3 system. This meets the normative requirements for buildings with thatched roofs (SANS/ IEC 62305 Part3).

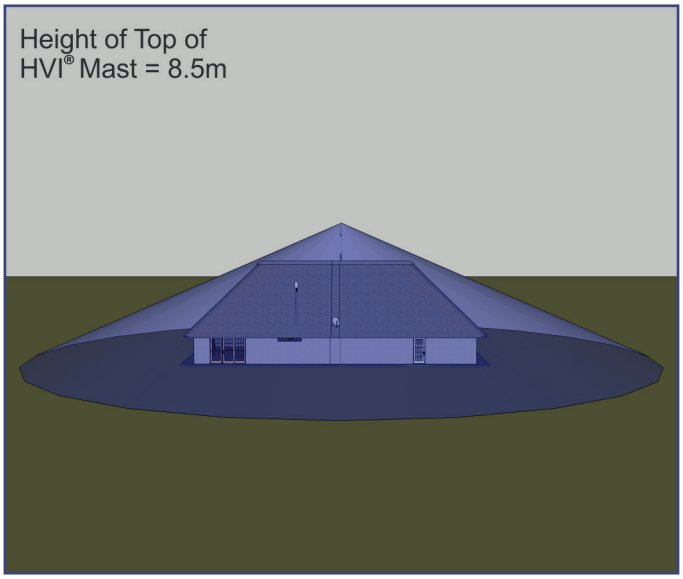
When designing the air termination system, the rolling sphere method or the protection angle method is used to determine the protected zones. According to the standards, a rolling sphere radius of 45m must be used for level 3 protection systems. In the sketch above, the height of the HVI® air terminal is 2.50m; this height ensures that the entire thatch roof is located within the protected zone.

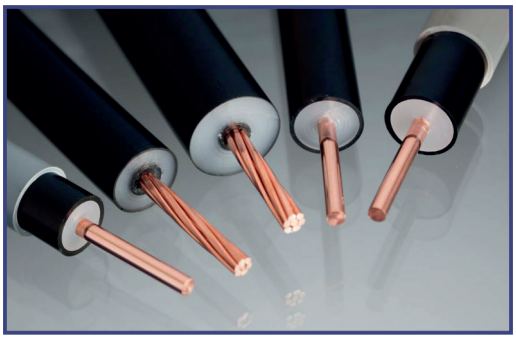
HVI® MASTS & CONDUCTORS

The top of the HVI® mast is equipped with a 1m stainless steel finial, and the supporting tube is made of GRP (glass fibre reinforced plastic) which houses the insulated HVI® conductor.

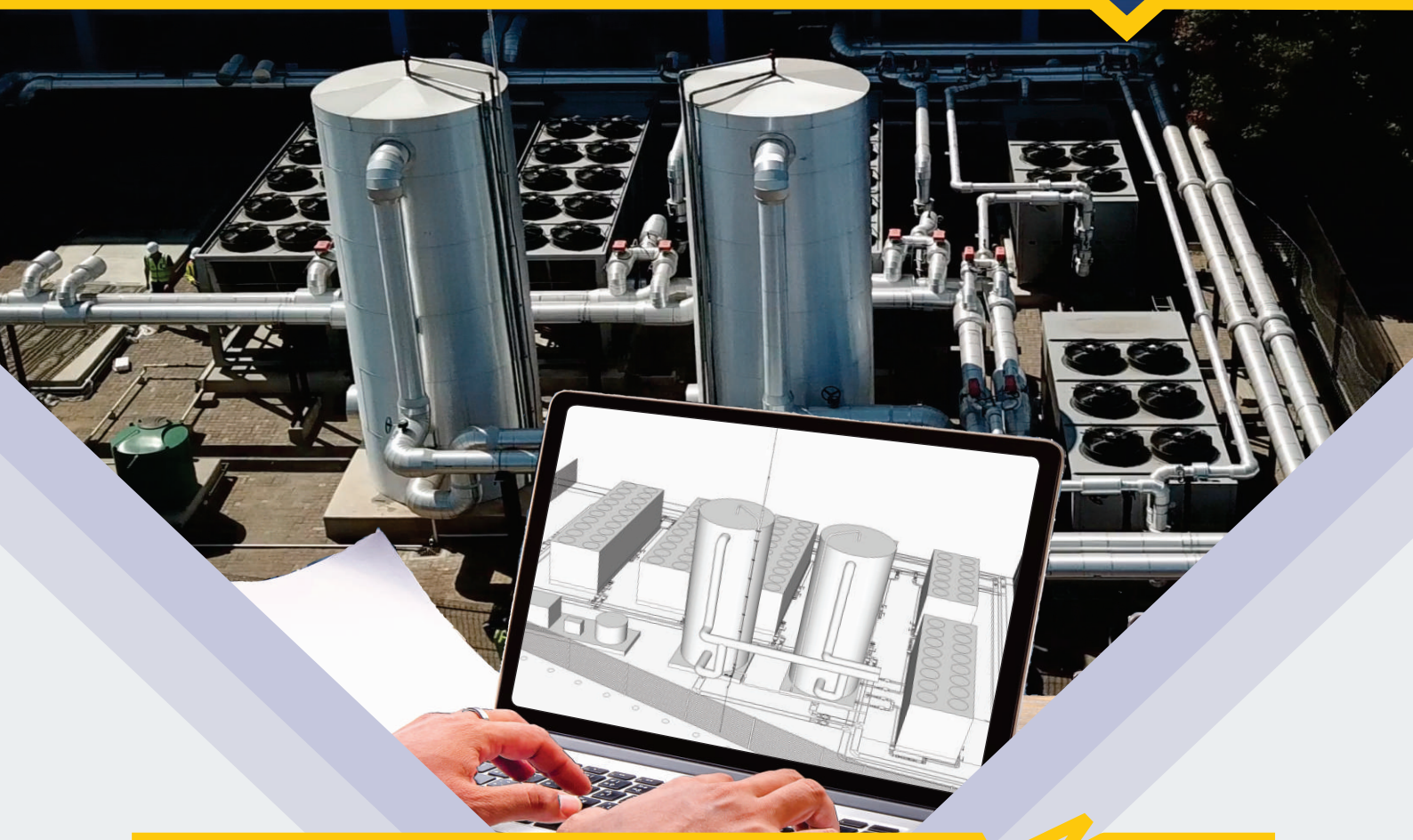
The lower end of the supporting tube is made of stainless steel to ensure stability. Unwanted sparking may occur at this point as a result of the induction effects on adjacent parts. To avoid this, no earthed







Masters in the Art of Lightning Protection



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Lightning Protection for Thatch Structures

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parts or electrical equipment may be located at a distance of less than 1m around the stainless-steel section of the supporting tube.

The HVI® mast is fixed to the wooden rafters by a specially designed bracket, and the HVl® conductors are run inside or underneath the thatching. This is easily achieved during the construction phase of the structure.

HVI® conductors are specifically designed to prevent creeping discharge and safe dissipation of lightning current and therefore are suitable for the protection of thatch structures.

SEPARATION DISTANCES

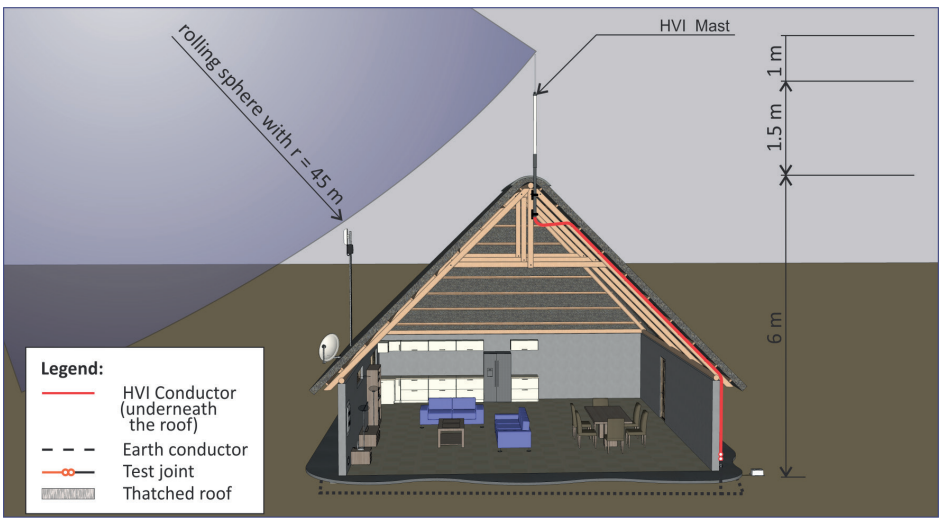
The separation distances must be calculated following SANS/ IEC 62305 Part 3. There are three different types of HVI® conductors; each has its equivalent separation distance:

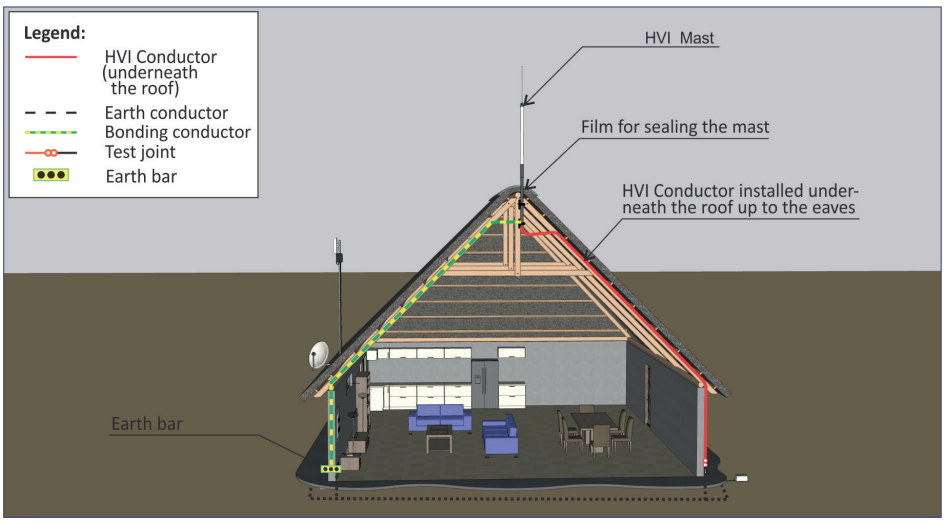
- HVI® light conductor;
  Separation distance= 45cm (air), 90cm (solid material)
- HVI® long conductor;
  Separation distance = 75 cm (air), 150cm (solid material)
- HVI® power conductor;
  Separation distance = 90 cm (air), 180cm (solid material)

Once the separation distance has been determined, then the appropriate HVI conductor can be selected.

The semi-conductive sheath of the HVI® conductor must be equipotential bonded; this can be performed at the building main earth bar.

All other equipotential bonding (electrical earthing system, water pipes, etc.) can also take place at the main earth bar.

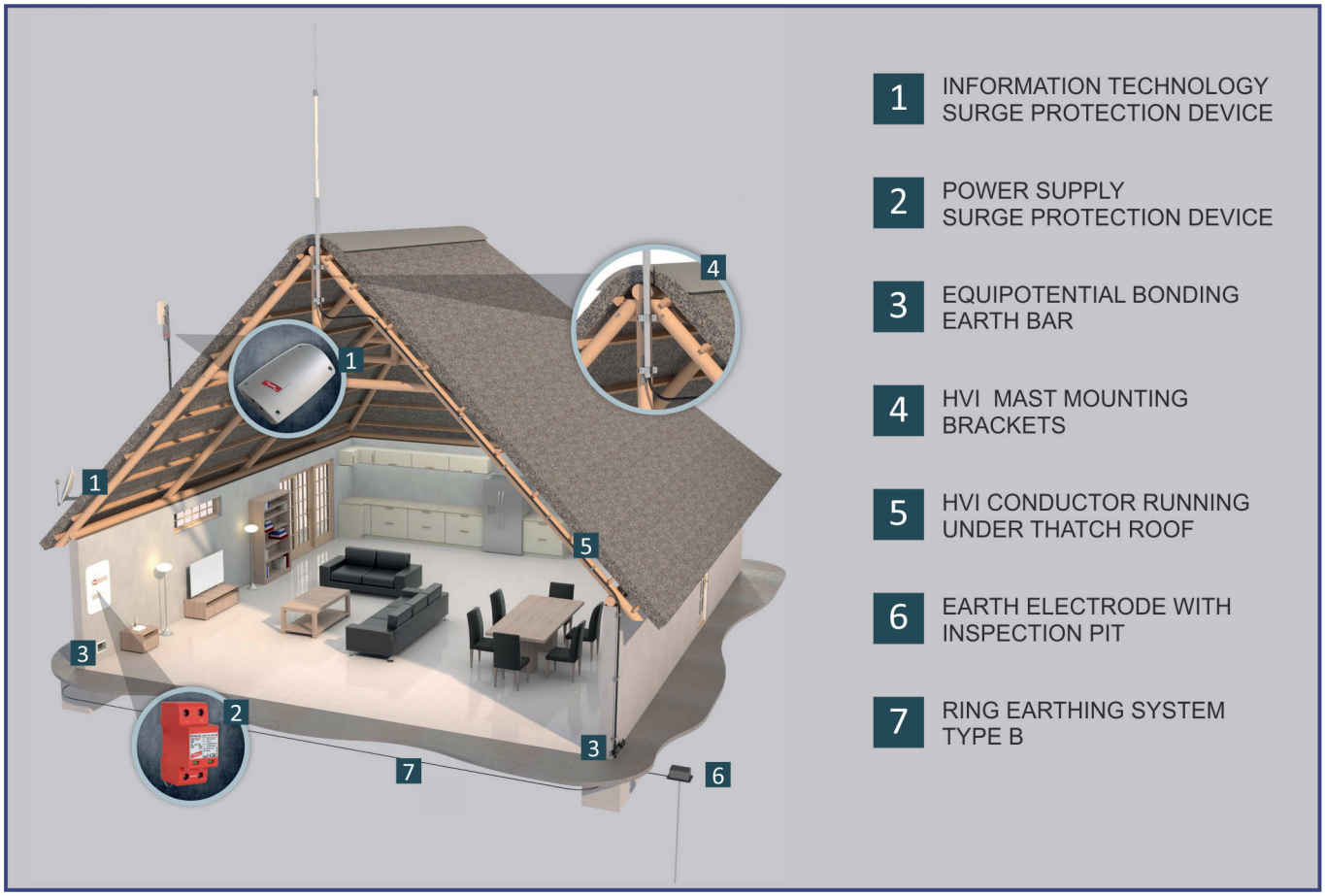




EQUIPOTENTIAL BONDING

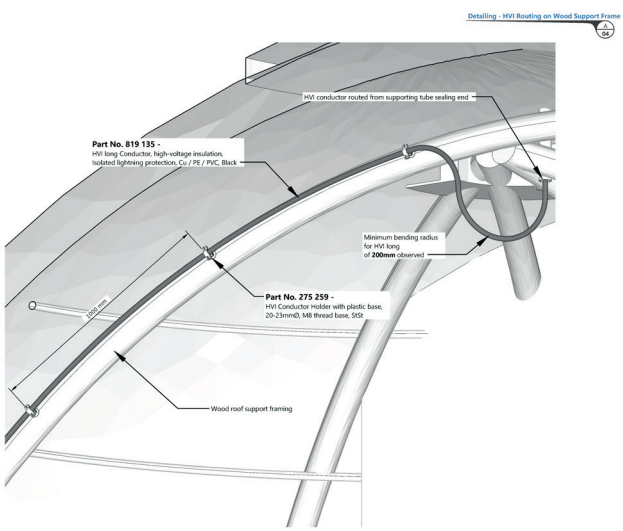
It is imperative that the semi-conductive sheath of the HV1® conductor is equipotentially bonded, this can be performed at the building main earth bar.

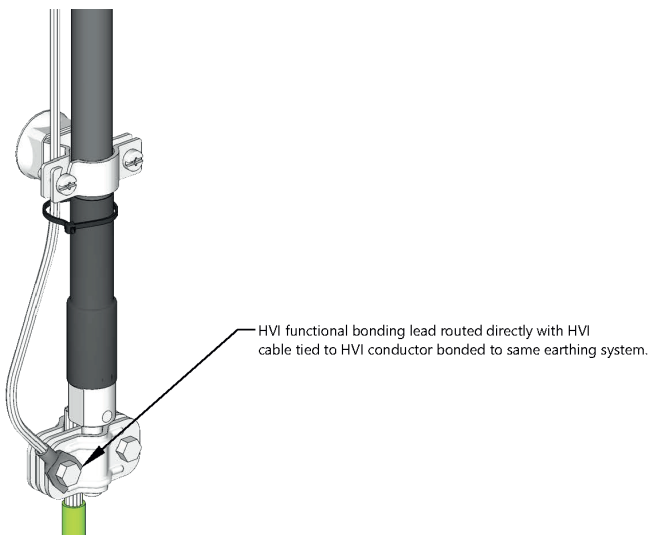
All other equipotential bonding (electrical earthing system, water pipes, etc) can also take place at the main earth bar.



Total HV1® Lightning Protection System

DESIGNS FOR THATCH STRUCTURES





Lightning Protection for Thatch Structures

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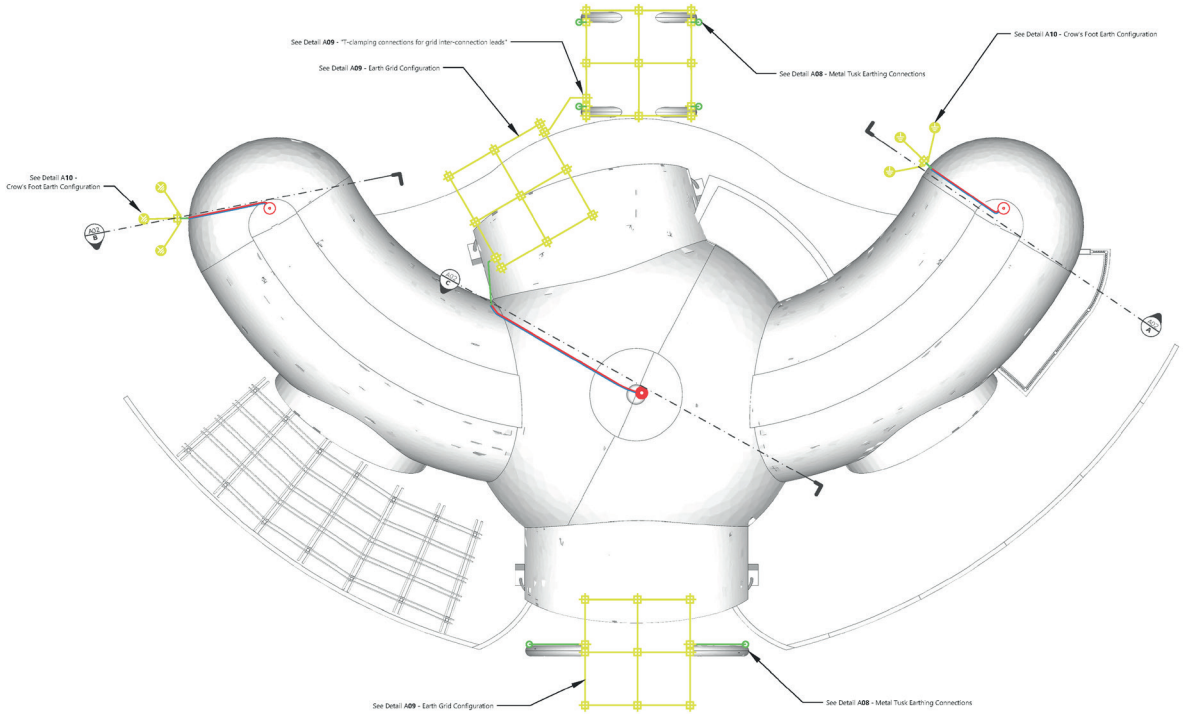

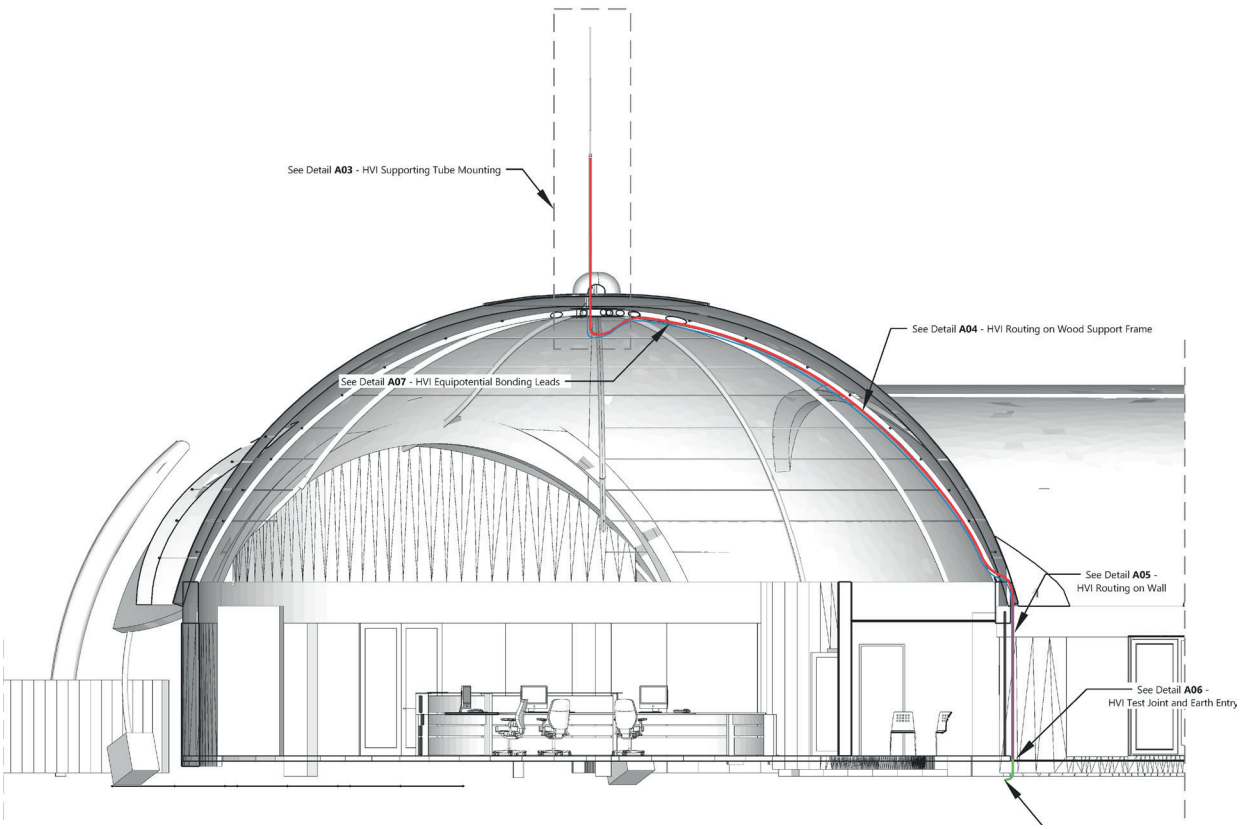

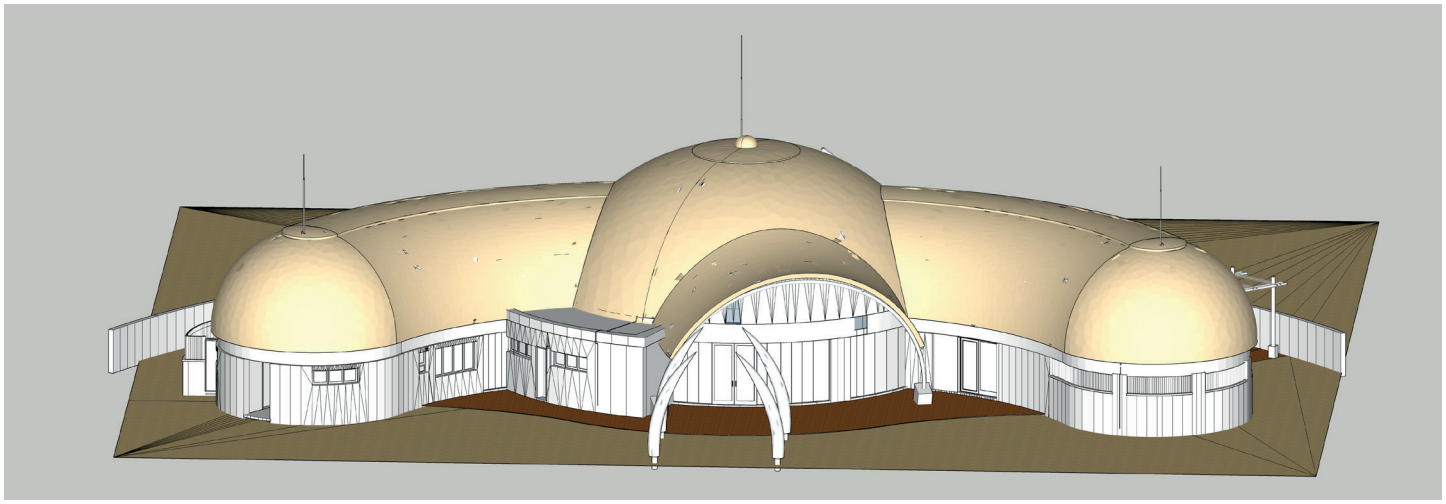

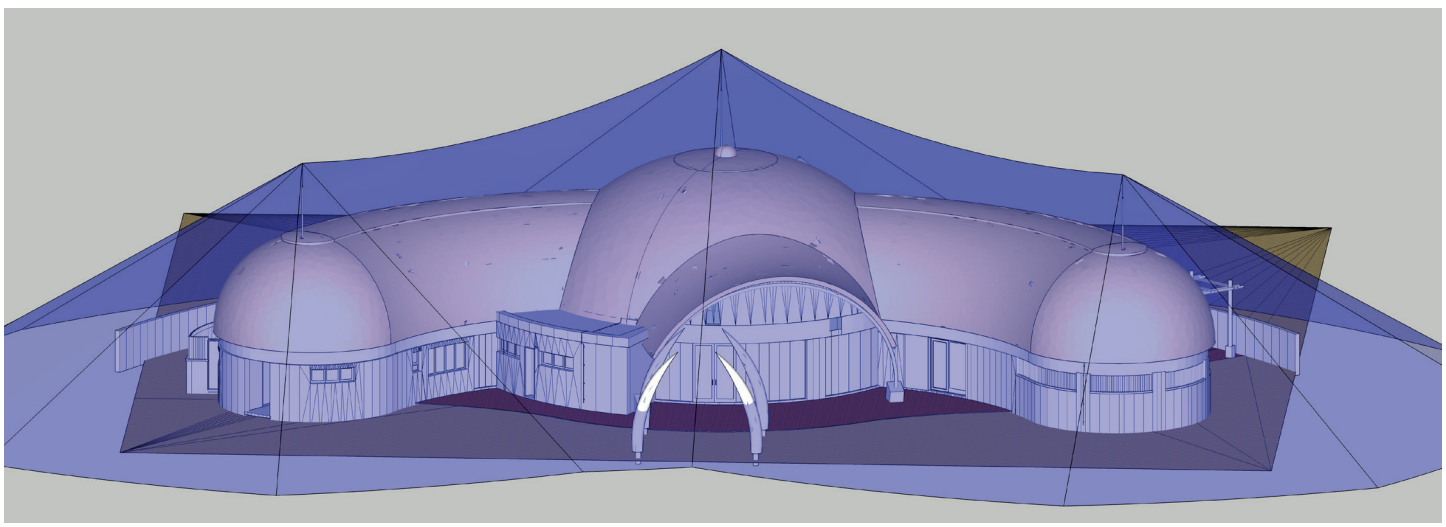

OVERVIEW

HVI® lightning protection systems are not only an alternative protection method for thatch structures, but they also provide more effective protection than conventional protection methods. The methodologies and lightning protection principles included in this report are following the latest revisions of the relevant standards.

The use of HVI® protection systems offers an aesthetically pleasing and cost-effective alternative to the traditional lightning protection methods for the protection of thatch structures from lightning.

This method of lightning protection (HVI® conductors) represents the latest and most up-to-date lightning protection technology available in the world today.

This report describes only one of many applications where HVI® separation distances (isolated LPS) are challenging to achieve. HVI® conductors can be utilised when the required protection systems can be used in zoned areas, explosive environments, rooftop plant, PV systems and HVAC systems.

ST -TALKS

Advantages and disadvantages of low lightning insulation level on overhead MV power lines

BY | A. BEUTEL (FSAIEE)
B. MCLAREN (MSAIEE)
H. GELDENHUYS (FSAIEE)
W. DIRKSE VAN SCHALKWYK (MSAIEE)
ESKOM HOLDINGS SOC LTD, SOUTH AFRICA

This is a summary of a paper accepted for presentation at the 9th CIGRE Southern Africa Regional Conference to be held in Johannesburg on 1st – 4th October 2019. The summary is included here with the permission of the organizers of the conference.

Eskom, South Africa's largest distributor of electricity, has standardized on a phase-to-earth lightning insulation level of 300 kV on its medium voltage (MV) overhead distribution lines. MV is defined as a phase-to-phase voltage of 11-33 kV in South Africa, with 22 kV being the most common. The 300-kV philosophy has performed acceptably over many years [1] and has been implemented by inserting a wood gap in series with the insulation provided by the phase insulators, as shown in Figure 1. The 300-kV level was chosen so that surges induced by nearby lightning strikes do not cause flashover.

Low Lightning Insulation Levels

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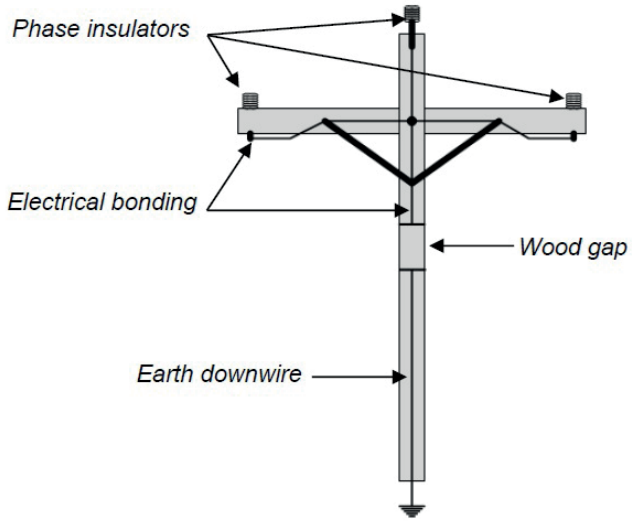

Figure 1 : 300 kV lightning insulation level illustrated on one structure configuration (wood pole and cross-arm used)

Figure 2 : Example of pole damage in the wood gap [1] (above left), mitigation solution [9] (above right) and a rare case of damage to a pole in the wood gap with spark gap inserted [9] (below)

Some cases of pole damage in the wood gap have been found, this is caused by flashover due to direct lightning strikes, an example of which is shown on the left of Figure 2. Figure 2 also includes an instance of the mitigation measure implemented; this is in the form of a spark gap that causes flashover across its terminals rather than across or through the wood. This spark gap has a 260 mm separation and has resulted in a significant reduction in wood damage. However, some rare cases of damage to poles in the gap have still been found [2], an example of which is shown at the bottom of Figure 2.

This has led to investigation into reducing the separation of the spark gap electrodes. The theory is that this will result in more surges causing flashover of the spark gap, and hence an even further reduced risk of wood damage. However, the theory also indicates that reducing the separation may result in a significant increase in the number of flashovers in conditions with high soil resistivity. This therefore requires further investigation, which is the subject of this paper.

THEORY

Figure 3 shows the relationship between the phase-to-earth lightning insulation level, referred to as the basic insulation level (BIL), and the number of expected flashovers for a

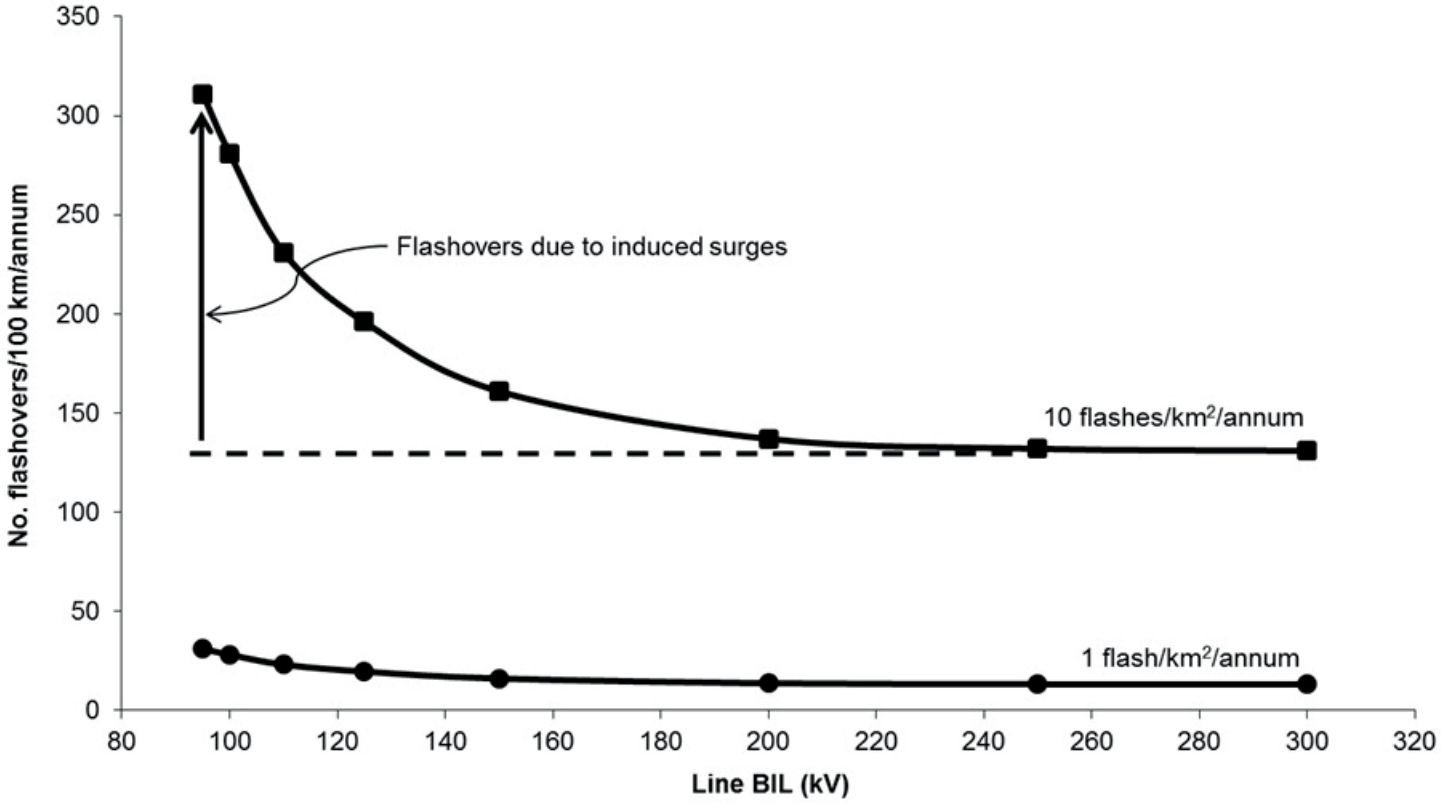

Figure 3 : Number of flashovers due to lightning as a function of BIL (derived from [3] and [4])

conductor height of 10 m. There are two curves, corresponding to lightning ground flash densities of 1 and 10 flashes/km²/annum. It can be seen that for a BIL of approximately 200 kV and lower, the number of flashovers increases with reduced BIL. Above 200 kV, the number of flashovers is relatively independent of BIL, i.e. the number of flashovers forms a horizontal asymptote. This asymptote represents the number of flashovers due to direct strikes, because induced surges are only large enough to cause flashover at a BIL of below approximately 200 kV.

IEEE Std 1410-2010 [5] has produced a similar graph taking the effect of soil resistivity into account. The effect of soil

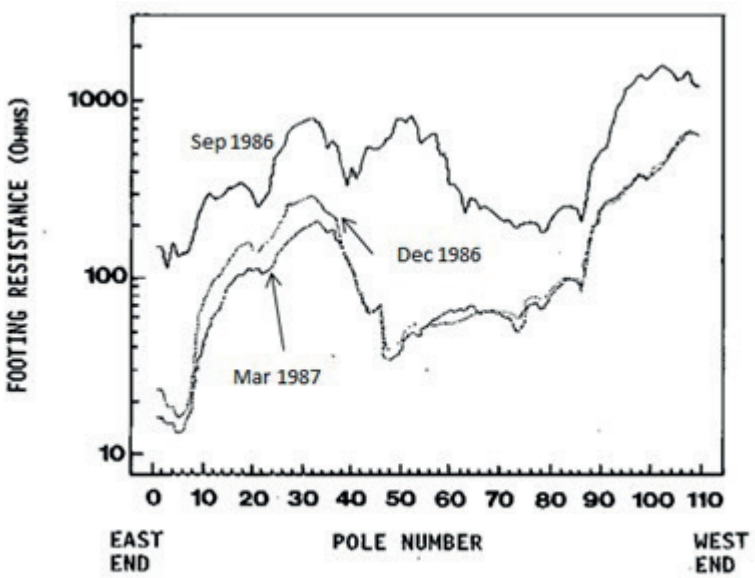

Figure 4 : Test line pole footing resistance (reproduced from [7])

Low Lightning Insulation Levels

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resistivity variation may be estimated by dividing the number of anticipated flashovers for 1000 Ω.m soil resistivity by the same for 100 Ω.m resistivity. The results indicate that the number of flashovers due to induced surges may be up to more than an order of magnitude greater for soil resistivity of 1000 Ω.m than for 100 Ω.m.

Soil resistivity can not only vary between different areas, but can also vary significantly from season to season, as illustrated in Figure 4 for a location near Pretoria, South Africa [6]. This graph plots measured earthing resistance for poles along a test distribution line and shows that soil resistivity varied between approximately 30-1500 Ω.m in summer and about 200-3000 Ω.m in winter.

LABORATORY TESTS

Typical values of line BIL were determined for different spark gap separations, this was performed in the high voltage laboratory at the University of the Witwatersrand using 1.2/50 µs lightning impulses as set out in IEC 60060-1 [7]. A multistage impulse generator, as described in Section 2.3.1 of [8], was used. The test setup is illustrated in Figure 5.

Comparing the test results to the theory shows that the effect of soil resistivity is expected to be negligible for a 260 mm spark gap separation (this is the separation currently used). A reduced gap separation resulted in a reduced BIL, as expected, but with minimal difference between 50 mm, 100 mm and 150 mm separations. The reason for the latter is under investigation but may be due to the effect of the wood pole on the waveform produced by the impulse generator.

It was found that the spark gap did not flash over every time that the insulator flashed over, in such cases the current flowed through the wood. This explains why, in certain cases where new (relatively wet) poles are used, the poles are still damaged with a spark gap installed (a new pole was purposefully used for the tests to test this hypothesis). However, it should be noted that such damage is extremely rare.

DISCUSSION

The theory indicates that applying a spark gap with a separation of less than the present 260 mm would result in significantly different performance in areas with different soil resistivity: the higher the resistivity, the more flashovers are expected, i.e. the larger the separation the better. However, the results of the laboratory tests indicate that the separation should be as short as possible to protect the wood by ensuring that flashover occurs across the spark gap. Combining the theory and laboratory results indicates that there is a "median" point where the risk of the type of spectacular damage shown in Figure 2 can be even further reduced from its present

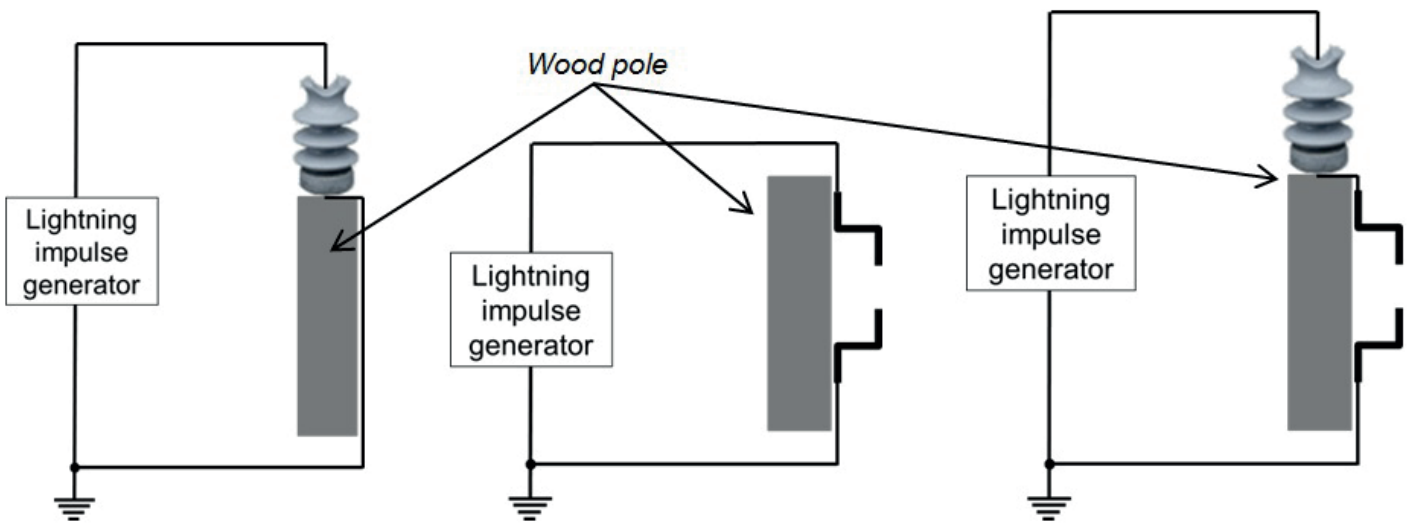

Figure 5 : Lightning impulse laboratory test setup – insulator only (left), spark gap only (centre), insulator and spark gap (right)

level, but where the effect of wet (new) wood and soil resistivity can be kept to an acceptable level. wn

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A dynasty of engineers

Three generations of tech Jacobsons serving society

COMMISIONED BY | JOHN GOSLING (FSAIEE)

He was dutiful but demanding, brilliant but impatient, sure of his opinions and his direction. At his funeral in 1960, an elder brother was overheard to say: "There goes the man with all the answers." He was also an "upstart colonial". What did the top business people in England and America make of this young South African some 80 years ago when he dared to negotiate deals with them?

His son, who hardly knew him as he died tragically young, still wonders.

He was Louis Jacobson, the first of three generations of Jacobson's to pass through the School of Electrical Engineering at Wits. His son David and grandson Sven have also excelled in a changing and challenging world, supplying some answers themselves.

First, that world needed raw materials and the power to extract them. Then it needed smarter, more efficient and more adventurous technologies and ways to make sense of information. And it always needs healing.

PIONEER IN SOUTH AFRICAN INDUSTRY

Louis Jacobson, born in 1910 in Johannesburg, was an entrepreneur and an industry pioneer. In his short life, he stood out as a designer of heavy electrical machinery and a builder of significant companies that manufactured it.

He graduated from Wits in 1932 with a BSc (Eng) in Electrical and Mechanical Engineering (this was before the term "electronics" had even been coined). He worked for two years at the Victoria Falls Power Company near Johannesburg. This company supplied electricity to industry, including the gold mines. He then founded Alpha Electrical, an electrical motor repair workshop. This became Alpha Harris Pty Ltd, a designer and manufacturer of professional electrical equipment, which grew into the renowned First Electric Corporation of South Africa Ltd (FEC) - the first of its kind to be listed on the JSE. FEC made an essential contribution to the World War 2 effort, for example by providing equipment for degaussing ships to protect them from magnetic mines. The company became today's Actom, still a significant producer of electro-mechanical equipment at Knights on the East Rand, once Louis's head office.

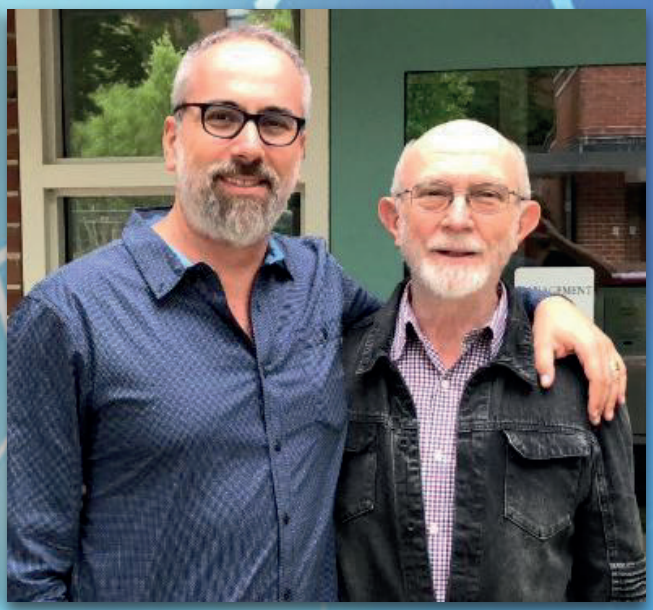
In the late 1950s, Louis's entrepreneurial spirit was ready for a new creation: FWJ Electrical Industries Pty Ltd, which he formed and led, in partnership with Carl Fuchs. One of FWJ's innovative developments was the world's first earth-leakage protection device for use in the mining industry, significantly reducing deaths and injuries from electrical shocks.

Louis married Edythe Sonnenberg, and they made a home in Oaklands, Johannesburg. At the time of Louis's death from a brain tumour at the age of 49, his son David Harris Jacobson was only 17, in his first year at Wits, and so he never really knew his father in an adult relationship.

TALENTED AND ORIGINAL

From an early age, David was interested in electrical and electronic technologies, and he built stereo equipment and radio-controlled model boats. Louis gave him a well-equipped workshop at home to develop

Louis and son David



Sven and father David

these scientific interests. Similarly, his sister Ruth Denise Leveson (née Jacobson, Wits BMus 1959) received a piano to develop her musical talent.

Mickey Milner (Wits BSc Eng 1957, PhD 1968) recalls David's student days: *"I served as a lecturer in Electrical Engineering at Wits. It was evident then that David was an extremely bright, talented individual with enormous potential to make significant contributions in his chosen field of endeavour. We became firm friends, even to this day, he claims (jokingly) that I spoilt his record of achieving first-class passes in all his final-year subjects, except for electrical machines, which I taught at the time."*

David graduated from Wits in 1963 (BSc Eng With Distinction) and married Lynne Yvonne Morris. Accepted for postgraduate studies at five of the world's top universities, he chose Imperial College in London. There he began exploring a field that was the forerunner of artificial intelligence. No computer was up to the demands of the project, and he was forced to abandon it, but that didn't stifle his innovative spirit. He completed his PhD at Imperial in 1967 under another Witsie, Professor David Mayne (BSc Eng 1951, MSc Eng 1956), who says: *"I would rank David as the most original PhD candidate among the many I have supervised."*

Prof Mayne recalls that David read a paper of his on differential dynamic programming and then, *"showing characteristic originality, very soon proposed a major new idea: the use of 'strong variations' for determining an improved trajectory using optimisation to choose an enhanced control by making significant variations in the control over small intervals of time rather than the universal procedure of making slight variations over large intervals of time. I did not at the time, recognise the value of this proposal and tried to discourage David from proceeding with this line of research. Again, showing characteristic courage, David persevered, soon proved me wrong, and went on to produce a highly successful and revolutionary theory."*

VERSATILE ALGORITHMS

David Jacobson's thesis, *"Differential dynamic programming [DDP] methods for determining optimal control of non-linear systems"*, used one of the most powerful computers of the day, the IBM 7090, to develop and test numerous new algorithms. The computational efficiency and range of applications of the algorithms attracted wide attention and use in fields such as aerospace, chemical, mechanical and other branches of engineering, economics, biosciences, robotics, artificial intelligence and dynamic games. For example, DDP was used in calculating optimal low-thrust trajectories for NASA's Dawn mission to the outer solar system – 37 years after Jacobson and Mayne's book Differential Dynamic Programming was published.

In 1967 Prof Mayne arranged for Harvard's Professor Yu-Chi (Larry) Ho to meet David, and this led to an offer of a postdoctoral fellowship at Harvard. Professor Ho says: *"The Department of Electrical Engineering of Imperial College and the Engineering and Applied Science Division of Harvard University had a 'special relationship' during the second half of the 20th century involving many exchange visits. Mayne introduced me to one of his PhD students, whom he mentioned as exceptionally bright and who was making*

A dynasty of engineers

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a breakthrough in the area of Dynamic Programming. I was not disappointed in Mayne's recommendation and subsequently hired Jacobson to begin at Harvard in 1968 as a postdoc and as an assistant professor. He was later promoted to Associate Professor. Jacobson was undoubtedly a rising star in the international system control field, with a brilliant publication record and excellent career future."

They kept in touch for more than 50 years, and Prof Ho says he treasures their scientific and personal interactions.

ATTRACTING EXPERTISE TO WITS

David returned to South Africa in 1972 for family reasons. He joined Wits as an applied maths professor and then moved to the Council for Scientific and Industrial Research (1975-1985), where he became deputy president from 1980.

As Director of the CSIR's National Research Institute for Mathematical Sciences (NRIMS, 1975-1980) he maintained the connection with Wits' Department of Computational and Applied Mathematics as an Honorary Professor.

He recruited high-level researchers from other countries to the Institute and placed several of them at Wits, supported by NRIMS funding, to boost capabilities, research, mentoring and publications at both institutions. The stature that this lent Wits and NRIMS attracted many talented mathematicians to South Africa.

Taking his knowledge of the commercial world was the next step. During the period 1985-2000, at the large Altron industrial group, as a main board director, he became well known for his expertise in new product development strategies and science and technology policy. He established and developed Altron's Technology Development Programme for innovation in all of the group's subsidiary companies.

David's keen interest and capabilities in policy were noted first by the ANC and then by the newly formed Mandela government and he became an advisor to the Minister of Science and Technology.

Those were stimulating and important times as the new government was focused on developing incentives and programmes to enhance South Africa's industrial and scientific advancement and build its reputation on the world scene. David contributed significantly to these tasks.

Serving his profession, David was Chairman of the South African Mathematical Society and President of the South African Institute of Electrical Engineers (SAIEE). He introduced new grades of SAIEE membership and criteria, which made the Institute more accessible to people lacking university degrees. This opened a career path for many people who became a credit to the profession.

David also served on the Wits Council from 1987 to 1997, and on the advisory committee of the then Vice-Chancellor, DJ du Plessis, on computer centre development.

REMARKABLE FIND

In 2000, David and Lynne relocated to Toronto, Canada. He started there as a senior technology advisor at the early-stage venture-capital company Primaxis Technology Ventures, and his versatility and experience soon attracted the attention of PricewaterhouseCoopers LLP (PwC).

Evan Kelly, then PwC's technology and telecommunications practice leader, recalls: *"We met for the first time over lunch and he immediately ordered a glass of red wine. I knew then that I was going to like this guy. Many things impressed me about David right away. Firstly, he had a remarkable ability to understand and explain technology across a whole spectrum of areas. This was truly unique.*

Typically, you find technologists who understand a limited number of areas deeply. David could dig in and understand many areas of technology and explain it to technology Muggles. This, combined with a solid understanding of business, made David truly a remarkable find. I hired David into a business development and marketing position, which was very odd within the world of PwC. His job description was to 'make himself useful' – and away he went."

He was appointed Director: Emerging Technologies at the firm and became widely acclaimed for his futurist presentations and advice to early-stage technology-based companies. Known as PwC's *"secret weapon"*, he helped the firm to understand emerging technologies and trends ahead of the competition, assess emerging companies as potential clients, access research and information, and open up new business opportunities and relationships through his network.

He amassed vast experience in working with inventors, entrepreneurs, researchers, venture capitalists and industry in a range of fields, such as electronics, manufacturing, telecommunications, nanotechnologies, wireless technology, heavy electrical equipment, robotics, cloud computing and social networking of computers.

He has published five technical books and over 100 papers since the PhD thesis that made such an impact in the 1970s and to this day. Prof Mayne says: *"An important fundamental contribution in his book Extensions of Linear-Quadratic Control Theory was his introduction of 'risk-sensitive optimal control'. His results triggered a significant development in optimal control theory."*

In 2015 David was acknowledged for his 1973 ground-breaking work on risk-sensitive decisions by Nobel economics laureates Lars Peter Hansen and Thomas J Sargent. They said he profoundly influenced the thinking that resulted in their book Uncertainty Within Economic Models. The book is dedicated to David, and he is referenced in Hansen's Nobel Speech Booklet, 2013.

David retired in 2012. He spends some time as an active investor, not a speculator.

He is interested in and reads widely on many topics, among them the origin of the universe, physics, internal medicine, professional medical papers with particular emphasis on medications and their side effects, and the varieties of human behaviour. He regards fiction as an essential window on human life and has been known to write poetry. Like his father Louis, he is a determined person, someone who doesn't give up easily, a problem-solver.

THIRD GENERATION

David and Lynne's daughter Lisa (Jacobson) Hoaken, born in 1967 in the UK, is a distinguished speech pathologist and businesswoman in Toronto. She is a graduate of the University of Cape Town in logopaedics and holds an MA from the University of Toronto. She and her late husband Eric have three daughters and a son.

David and Lynne's son Sven Martin Jacobson was born in 1969 in Cambridge, Mass., USA but, along with Lisa, grew up mostly in South Africa. Inheriting the family's scientific and entrepreneurial mindsets, he graduated from Wits in electrical engineering in 1991 and with an MBA in 1995.

He worked as a software engineer at Teklogic and then joined the Rennies Group in South Africa, rising to the position of board director of the Travel and Financial Services division, responsible for a diverse portfolio which included IT and account management.

He and his wife Sonia (née Learmont; Wits BA 1991 and New York University MA), who has practised as a Licensed Master Social Worker in New York City, moved to Brussels in 1999 and then to New York in 2001. They have two sons.

Sven is a partner at Carrot Capital, a venture capital company in the healthcare industry, and CEO of several companies which he formed with Carrot Capital managing partner David Geliebter. They focus on repurposing old and abandoned pharmaceuticals into new treatments for life-threatening conditions.

Remedy Pharmaceuticals, of which Sven is the CEO, developed an innovative drug to treat severe stroke and recently sold it to Massachusetts-based Biogen. At present Sven is focusing on his new venture Martin Pharmaceuticals, which is developing a treatment for acute-on-chronic liver failure.

Though Sven concentrates his efforts in the medical world, he regards his education at Wits in electrical engineering and business as excellent preparation. It enabled him to research and understand the science and technologies of pharmaceuticals, communicate effectively with leading medical researchers worldwide, and create pharmaceutical business ventures aimed at alleviating human suffering.

He is another determined problem-solver. David is delighted to have his *"friendly giant"* (6 foot 3) son as a role model. He credits Sven with great clarity of thinking, creativity and wisdom. They share an interest in reading, travel, food, movies and, above all, how new concepts are created, emerge, and develop to the benefit of humanity.

LOOKING BACK AT THE FUTURE

Many of David's predictions made during the years 2002-2012 at PricewaterhouseCoopers in his role as "futurist" have come to pass:

- the dramatic rise of cloud computing;
- the conviction that "ubiquitous participation", a concept which he introduced, would become commonplace. It has done so, as a consequence of Steve Jobs' handheld communications platforms, notably the iPod, iPad and iPhone;
- the emergence of social networking of machines, over and above that of people. He foresees much more depth and breadth of research and innovation being necessary before such automatically corresponding machines and associated Artificial Intelligence will yield the promise currently circulating in the popular media. Perhaps a task for another generation of Jacobsons or Hoakens?

A dynasty of engineers

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David hopes to pass on the culture of learning and problem-solving to his grandchildren and great-grandchildren. Certainly, there will be no shortage of significant problems to solve.

Perhaps some of the Jacobsons' work will help the next generation to innovate in space exploration, industry, commerce and healthcare, improve our environment, or even turn the tide on the current wave of autocracy, which is sweeping countries worldwide. The family sees this trend as the most vexing problem of our time. wn

Article courtesy of Wits alumni.
24 July 2019 – Wits Alumni Website: https://www.wits.ac.za/news/sources/alumni-news/2019/a-dynasty-of-engineers.html

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David capping son Sven

Louis graduation 1932

SVEN:
http://www.remedypharmaceuticals.com/ http://www.martinpharma.com/ https://vimeo.com/165886292 Jaclyn's Story, Remedy Pharmaceuticals

Louis second on the left with General Smuts at Rand Show
ALPHA HARRIS/FEC Exhibit

David revisits FEC in 1981

WHAT IF?
- 4th Industrial Revolution and new technology

Between1960 and 1980, as a power distribution engineer, my passion was to provide a reliable electricity supply to Johannesburg consumers.

BY | STAN BRIDGENS
PR ENG FSAIEE FSAAE

The benchmark time to restore a medium voltage fault was 23 minutes and 30 minutes for higher voltage level disturbances on the network.

Consumers who were encouraged to use more electricity were advised to expect two outages of 30 minutes per annum. If more interruptions were experienced, they were encouraged to bring this to our attention and remedies were sought.

This was at a time where the growth was just less than 10% measured in the maximum demand for electricity.

So one can imagine that there was a significant capital expansion to double the capacity of the grid/network every seven years, to cater for the doubling alongside the structures.

THOSE WERE THE DAYS – THINGS AND TIMES HAVE CHANGED!

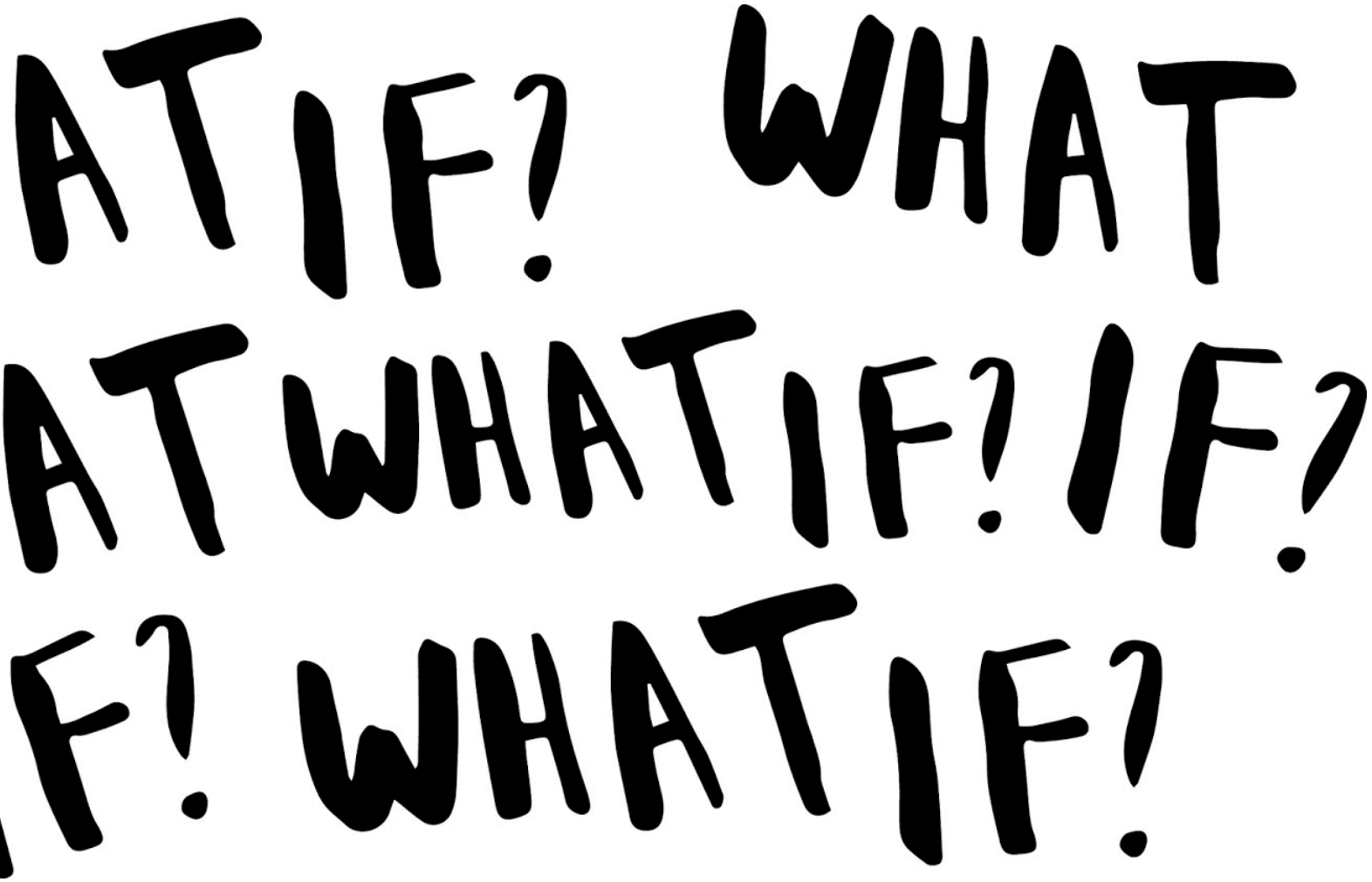
THESE ARE THE DAYS NOW, AND THINGS ARE CHANGING FAST

If you think about it – the rate of change now - is the slowest we can expect going forward. In other words, the rate of change is only going to increase in future!

The drivers of these new things are much younger people than me. More adventurous and open to new ideas and dare I say smarter? I sometimes question if they are wiser. The graduates are more intelligent and younger. They have a higher understanding of absorbing new technology and applying it.

Many corporations are governing the thinking of people in the use of their new high-tech products. “If you don’t follow their/our rules – don’t expect the benefits of our products”.

Gradually new technology is driving away the need for people to do menial, physical,



repetitive, tedious work – and doing a better, more consistent job with increased productivity. Releasing people to do other things.

Machine learning based on statistics from massive data, providing options for decisions to be made and releasing professionals to do other things - more importantly, from decision-making.
Access to infinite information to everyone provides self-learning. Including fake news!

Governing countries by tweeting?!
Social media are taking away the fundamental of humans to socialise. Abuse and defaming of people together with cybercrime stealing people's assets. This is some of the evidence that abounds.

SO WHAT?

All this is releasing people to do their things. What other things I ask and does this lead to freedom? Does this give self-achievement and self-satisfaction, or does it take away the fundamental needs of humans – that Maslow's triangle of human needs talks about.

More importantly – if new technology is to benefit humanity – care must be taken to avoid or at least understand and address fundamental needs across the spectrum of basic human needs.

This is particularly pertinent to South Africa, where the weak education system exacerbates the ability to upskill, adapt and change.

Widening the technology gap between those that know and those that don't know, can only assist and exacerbate the widening of the wealth gap – something South Africa definitely cannot afford.

So, I ask myself what contribution should be made in developing young engineers?

I pioneered the implementation of prepayment meters in the Johannesburg area of supply in the late nineteen eighties. New technology at the time and the experience gleaned has influenced my thinking about the 4th Industrial Revolution and the implementation of new technology today. I had the first-hand experience of the impact of prepayment technology for electricity on communities - meeting them face-to-face akin to a baptism of fire. I learned a lot about how people react to change. Today more than ever, this is still an issue of concern.

If one looks at the evidence and the ubiquitous misbehaviour that abounds, I think the lessons learned then are as much as ever applicable and pertinent today.

The fact that survival of the species in the metamorphosis that new technology brings will ultimately depend on the ability of people to change and adapt.

What if?

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Thus, my focus in the mentoring arena is to influence the prediction, assessment, addressing of and consequence alongside the enormous potential benefits that new technology no doubt brings.

In short, the focus must be to understand and address the wholistic impact of new technology - especially on ordinary people.

Robotics, computer control, artificial intelligence, machine learning are components of the new environment. If you couple this environment with access to an infinite amount of information and unfettered access to experts around the world that our younger generation has at their disposal, then this will have a significant impact on mentoring in general.

Is there a need for mentoring? When I look at the evidence that prevails, there is now even more imperative to influence those bright and fully equipped young minds to engender wisdom. Being smart in bringing benefits of new technology to people must be tempered with sense to fully understand the holistic impact, particularly on ordinary people, as well.

The drivers, leaders and implementors of new technology (not confined to engineers only) need to be influenced to focus more on the adverse aspects alongside and preferably before the implementation of new technology.

I, therefore, conclude that mentoring and professional development of our new young engineers – the arena in which the SAIEE is involved with – has become my ongoing passion.

The need is epitomised in a TV advert that I am sure you have all seen:
It shows a man sitting in the back of a driverless car asking the question – WHAT CAN GO WRONG? After a few more examples of a drone and a robot asking the same question – the advert goes on to suggest an umbrella of insurance will fix them - when things go wrong.

In computer systems and applications, the same thinking exists. Suppliers implement or force the client to upgrade to the latest version of their product.

They then ask the client when they find a bug or when the system fails, to let them know and they will fix it. They call this a system patch.

The problem is that where new technology impacts on the safety, security and welfare of people, no amount of insurance or patches can fix the loss of life or the well-being of people.

This strategy of implementing new technology and fixing it when things go wrong prevails. This does not work so well when one is sitting in an aircraft or any travel for that matter. In short, the question must be asked "WHAT IF?" preferably before the implementation of new technology.

SO here's the thing!
Engineers are trained to predict, assess the impact and address the consequences of their creations. This is fundamental to their thinking and training.

So I believe engineers have a significant part to play in influencing the drivers and implementors of new technology across the board.

Prevention in this arena of the 4th Industrial Revolution is better than cure!
And so to the present...

THESE ARE THE DAYS - THINGS ARE CHANGING

The question may be asked – is there a need for mentoring our young engineers?

When I look at the evidence of cybercrime, and the impact on people, there certainly is an even greater need than before.
The real message is - when things go wrong, fix it with insurance.

This strategy does not work too well when you are sitting in an aeroplane or travel for that matter. No amount of insurance or patches will fix the loss of life.

There seems to be a lack of focus to predict and assess the impact or consequence of implementing new technology.

Wherever people's safety, security or well-being is impacted on in any way good or bad, it is essential to have answered the WHAT IF question.

So I believe the main element of my influence over young engineers is to have a holistic understanding of the impact of new technology, particularly the effect on people. South Africa cannot afford to have a technology gap created that supports the widening of the wealth gap. The rich get richer, and the poor get poorer.

The drivers of these new things are mainly younger people. More adventurous and open to new ideas and dare I say smarter? I sometimes question if they are wiser.
Many corporations are governing the thinking of people in the use of their new

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Gradually new technology is driving away the need for people to do menial, physical, repetitive, tedious work – and doing a better, more consistent job and with increased productivity. Releasing people to do other things.

Machine learning based on stats from massive data, providing options for decisions to be made, releasing professionals to do other things -more importantly, from decision making.

Access to infinite information to everyone and providing self-learning. Including fake news! Releasing the need to be tutored and mentored – it would seem.

Governing countries by tweeting! Releasing people to do their own things. Freedom?
So, I ask myself what contribution should be made in developing young engineers?
The graduates are smarter and younger. They have a higher awareness of absorbing new technology and applying it. At the outset, there are significant advantages and many breakthroughs.

Looking at the evidence from my perspective:-
Texting in place of or instead of socialising. Addiction to social media. Enhanced ailments of depression. Misbehaviour and abuse with access to instant information. Cybercrime and fake news.

While there is no doubt about the advantages – I think there is a loss of focus on the impact – more specifically on ordinary people.

And so I come to some conclusion as to what I think needs in the way of mentoring. People are being released from doing things taken over by new technology – released to do what?

Perhaps it is a fundamental need for many to do physical work and to sweat a little – instead of sitting in front of a screen and a panel of buttons for 8 hours a day?

Perhaps self-achievement and satisfaction and contentment is for some the ability to do things instead of having things done while people are set free to do what?

The modern strategy is to implement new and then assess the weaknesses.

You have all seen the TV advert about – "what if things go wrong" showing drones and self-drive cars and robots. The message is "it's going to go wrong - so insure". Many computer systems add new versions, and the strategy is to let the client find the bugs, and we will supply patches to remedy. Again *"let it happen, and then we will provide a fix"*.

There are some applications where the risk of going wrong is not an option. I refer to the recent air disaster that cost many lives.
I could go on but enough ...

Engineers have been trained to predict and assess the impact of their creations. I think engineers have a crucial part to play in understanding the implementation of new technology, predicting and preventing adverse effects on ordinary people.

To counter the new strategy – of trial and error.

We need to avoid creating a technology gap similar to the wealth gap in the financial sector where the rich get richer, and the poor get poorer.

More important – if new technology is to benefit humanity – care must be taken to not take away fundamental needs across the spectrum of basic human needs. This is particularly pertinent to South Africa.

So, Mr President, I stand here as a proponent for the focus on predictability and impact on people – before the implementation of new technology, particularly as it impacts on people. The people should be the beneficiaries of new technology as a priority – not corporations and smart people. wn

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Understanding the future through Business Intelligence

In order to successfully plan future business strategies and identify areas that need improvement in their operations, organisations need to analyse and interpret data and extract relevant information from it.

BY I TIAAN ROSSOUW

In fact, the effective use of Business Intelligence (BI) and analytics could mean the difference between companies that succeed and ones that fail, as this information is key to get ahead of the competition.

In most cases, large amounts of enterprise data are stored across servers, databases, spreadsheets and lately, somewhere in the cloud, and BI solutions can be used to extract this data directly from the data source and produce accurate reports and dashboards.

Fortunately, in this day and age, with everything being stored in electronic format, it has become significantly easier to extract business-critical data. As soon as you access data stores and extract the relevant information, you can analyse what is going on inside an organisation.

BI can be seen as a subset of Data Analytics. Data Analytics refers to the process of analysing raw data to make conclusions about that information.

Meanwhile, BI focusses on taking the millions of rows of data and delivering it in a format that can quickly and easily be interpreted to provide business value.

So, this is where technology-driven BI solutions come into play and take those analytics and throw them onto something visual, in typical cases a bar graph or a pie chart, so you can, at a glance, see which data is valuable to you. One such solution is Microsoft Power BI, which brings together data from various sources, and represents it in an interactive dashboard.

Power BI offers a host of functionality that make it a powerful and yet easy to use tool to collect and interpret key business data.

The solution runs on the cloud and allows the user to share dashboards with anyone with a Power BI license, even outside of your organisation. Designing a dashboard could be as easy as a simple drag and drop of a visual, or as complex as creating industry specific queries with R - a powerful language that can be used in Query Editor to prepare data models and create reports.

Users can also easily access the dashboards via any mobile device and – as Power BI is a Microsoft product – it offers seamless integration with any of the other Office 365 teamwork and collaboration tools.

One of the big strengths of Power BI is that it can pull data from almost any data source you can think of. As a Microsoft product, connecting to on-premise SQL Server, SQL Analysis Services server or Access database, or the Azure version of these services only takes a few clicks.

While it does that very well, it also goes further and can access free platforms like MySQL, and enterprise databases like SAP HANA, SAP Business Warehouse, Oracle, IMB DB2 and Sybase and some of the traditional competitors to Microsoft in the cloud space, for example Amazon Redshift and Google BigQuery.

From a non-database perspective, Power BI can link to simple data sources like Excel files or PDFs. It can also pull data from online services like Google Analytics, Adobe Analytics and third-party tools like Sales Force and ZenDesk. In fact, you can query anything with an API interface.

But what differentiates Power BI from the hundreds of other dashboarding tools available is probably best summarised by Gartner, who recently again placed Microsoft as the leader on their Magic Quadrant for Analytics and Business Intelligence Platform based on their ability to execute and the completeness of vision of the product.

For a pricing perspective, the cost of Power BI is OPEX based, and you only pay for the users that access the service. wn

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5-6	Fundamentals of Developing Renewable Energy Plant - Cape Town
10-11	Practice of Management for Engineers
10-12	Substation Design and Equipment Selection
12-13	Fundamentals of Long Term Evoluton (LTE) Mobile Communication
16-17	Photo Voltaic Solar System - Cape Town
17-18	Fundamentals of Developing Renewable Energy Plants
17-20	Advanced Microprocessor Based Power System Protection
26-27	High Voltage Testing and Measurement
27	Road to Registration for Engineering Candidates
OCTOBER	
8-11	Managing Project Effectively
9-10	Design Of Economical Earthing Systems For Utility Electrical Installations
14-16	Power System Protection - Western Cape
15-16	Photovoltaic Solar Systems
17-18	Optical Fibre Technology and Networks (OFTN)
17-18	Earthing and Lightning Protection - Western Cape
22-23	Incident Investigaion And Management (Incl. Root Cause Analysis)
23-25	Fundamentals Of Medium Voltage Protection
24-25	LV, MV & HV Switchgear Operation, Safety, Maintenance & Management
29-31	Contracts Law Masterclass
NOVEMBER	
5-6	Fundamentals of Long Term Evolution (LTE) for Mobile Communications
7-8	Advanced Microsoft Excel: Practical Data Management Applications for Engineers
12-13	SANS 10142-1. 2017 Edition 2 & OHS Act
13-14	Leadership Management Principles & Practice
14-15	Electrical Engineering Fundamentals for non-Electrical Engineers

** PLEASE NOTE: The above courses are only confirmed on condition that a minimum number of registration are received. The course dates are subject to change. The SAIEE reserves the right to cancel any course.*

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Our Expert Answers

Information provided by Zest WEG Group

QUESTION ONE

In terms of electric motors at what kW rating is it recommended to transition from low voltage (LV) to medium voltage (MV)?

ANSWER ONE

Motors are generally classified as low voltage when they are less than 1000 V, and medium voltage when they are greater than 1000 V. In South Africa low voltage motors are rated most commonly at 220 V, 380 V, 525 V or 690 V at 50 Hz. Medium voltage motors are rated most commonly at 3300 V, 6600 V or 11 000 V.

The answer to the question is not a one-size-fits-all case and should depend on specific application parameters discussed later. From a manufacturing perspective, the practical limitation for producing low voltage motors is around 1000 kW. Although theoretically possible to go beyond this, the large conductor sizes (due to the large current of the machines) make construction above this rating impractical and the performance inefficient. From an operational or plant point of view, it is common for the transition point to be specified at a much lower level than this generally.

Perhaps the better question to ask is: Should a specific kW transition level from LV to MV be specified as a blanket rule across the board?

Many existing specifications do stipulate this transition point as a blanket rule, expected to be followed and applied in all cases and regardless of specific application parameters. Some of these specifications often prescribe this level from LV to MV as low as 160 kW to 200 kW. While this does have merit, there is a valid argument for increasing this level, and in some specific circumstances. These specifications were often written at a time when it could be assumed that the vast majority of these electric motors would be direct online (DOL) started. The main intention was, therefore, to reduce the starting current demand, numerous large LV motors would have at the LV transformer level.

Generally, LV transformers on a plant would follow a conventional sizing of not higher than 2.5 MVA. Multiple large DOL motors starting on a single LV transformer would result either in a significant voltage drop or require a dramatic increase in their size to prevent excess voltage drop during large motor DOL starts.

Today, however, it needs to be considered that, increasingly, electric motors are using electronic Variable Speed Drives (VSD) or other solid-state starting methods. This reduces the starting current to a fraction of the DOL starting current value and potentially allows this transition threshold to increase where merited.

For example, in the case of the 160kW transition, the capital cost for installation of the MV motor VSD system versus LV motor VSD system is very large for little to no operational benefit. As this size increases, this capital cost gap narrows, making the transition to MV more viable.

Besides, as the size increases, other operational factors add benefit to the MV case, for example:

- Cable losses - which are higher in low voltage where higher current increases I^2R losses, particularly in excessive length cable, run.
- Harmonics - increase heating of transformers and other equipment. The higher the total load of VSDs on a transformer, the more this needs to be considered in the sizing and design of that transformer. In general LV VSDs are not supplied with inherent harmonic mitigation, whereas MV VSDs are.
- Approximate ratio of Capital Equipment Cost of MV to LV VSD and motor systems. Note this only considers the VSD and motor equipment and not the installation, cable, or other. This also does not include operational costs, which would become a determining factor as the kW rating increase, and the Capital Cost gap decreases.
  160 kW : 9.0
  300 kW : 4.5
  500 kW : 3
  750 kW : 1.75
  900 kW : 1.0

In summary, it seems appropriate that a transition point between LV and MV, if required, should possibly be implemented as a guideline. Specific application parameters, such as use on VSDs, may warrant a review of the transition point.

Other factors need to be considered, such as:

- Starting method (VSD, DOL, Soft start)
- Cable length, cable losses
- Network strength (includes voltage drop and transformer limitation)
- Capital cost vs total operation costs
- Harmonics, in the case of VSDs

What to consider when selecting a kW rating between LV and MV motors and VSD selection, including consideration of transformer sizing and selection.

QUESTION TWO

How do VSD harmonics affect the selection of my transformer?

ANSWER TWO

Most VSDs use diode bridge rectifiers, which result in a distorted current being drawn from the supply. This distorted current can be characterised in the frequency domain as containing multiple orders of harmonics (sinusoidal waveforms of increasing frequency relative the fundamental frequency, superimposed on that fundamental frequency). Ultimately, these harmonics create unwanted heating of the upstream transformers they are connected to and therefore affect the transformer sizing and selection.

The additional heating of the transformer has two leading causes:

1. Additional "wasted" current needs to be added to the useful current in the case of harmonic loads. For example, in the case of a six pulse VSD, the general total harmonic current distortion (THDi) as a percentage of the primary 50 Hz current is approximately 35%. In the simple example of a 100 A VSD, the fundamental current required by the load is 100A. However, the harmonic distortion of 35% requires additional current to be provided by the transformer. This needed total current can be calculated as the RMS sum of the primary current (100A) and the distortion current (35A). The result is 106A. Therefore, 6 Amps of additional "wasted" current needs to be added to the transformer load.
2. Harmonics causes increased losses in the transformer, particularly Eddy current losses. This increases the internal heating of the laminated transformer core.

Europe uses a formula prescribed by BS 7821 Part 4 to work out a derating applied to a conventional transformer - based on increased current and heat losses. This method is called Factor K.

The USA method deals with this slightly differently. The USA method focuses on the actual transformer design as opposed to merely derating. This method applies a formula to calculate a so-called K-Factor number. This number is used as a measure of the amount of harmonics a transformer is exposed to and is focussed on dealing with the harmonics issue at design and manufacture stage of the transformer. For example, the transformer will be specifically designed to decrease the overall losses and deal with the increase in heat to meet the harmonic demands. wn

August in History

August is the eighth month of the year in the Julian and Gregorian calendars, and the fifth of seven months to have a length of 31 days.

COMPILED BY |
JANE BUISSON-STREET
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1 AUGUST

1774 Jonas Priestley conducted an experiment during which he focused sunlight through a lens to heat a sample of mercuric oxide using a pneumatic trough. The result was a gas that allowed a candle to burn brightly, and also enabled a mouse to live for a long period while under glass. *"I have discovered an air five or six times as good as common air,"* he wrote – it was Oxygen.

2 AUGUST

2018 Apple became the first American public listed company to reach $1 trillion in value.

3 AUGUST

1933 The first Mickey watch was sold at the Century of Progress International Exposition in Chicago, USA. It was sold for $3.75 (equivalent to $73 (about R1070) in 2018).

4 AUGUST

1922 AT&T and Bell Systems honoured Alexander Graham Bell who had died two days earlier, by shutting down all their switchboards and switching stations. The shutdown affected 13 million phones.

5 AUGUST

2011 Juno was launched from Cape Canaveral Air Force Station on a mission to Jupiter, it was the first solar-powered spacecraft to go to Jupiter. Juno entered Jupiter's orbit 5 July 2016 to begin a scientific investigation of the planet and is still in orbit. After completing its mission, Juno will be intentionally deorbited into Jupiter's atmosphere.

6 AUGUST

1991 Tim Berners-Lee released files describing his idea for the WorldWideWeb – the first web browser and it was debuted as a

"It's not an electrical problem. Something's wrong with your corporate DNA!"

publicly available service on the Internet. Later WorldWideWeb was renamed to Nexus in order to avoid confusion between the World Wide Web and the web browser.

7 AUGUST

1948 As rain was starting to come down during the closing of the women's track and field event of the Summer Olympics was coming to an end, no American woman had taken a gold medal in any of the competitions. Alice Coachman changed that by soaring an unprecedented 5 feet, 6 1/8 inches (just over 1.68m) in the high jump at the London Games. She also jumped into the history books as the first black woman ever to win an Olympic gold medal.

8 AUGUST

2000 The H.L. Hunley (a submarine of the Confederate States of America that played a small part in the American Civil War) was raised from ocean bottom after 136 years. The sub had been lost during an attack on the U.S.S. Housatonic in 1864. The Hunley was the first submarine in history to sink a warship.

9 AUGUST

1910 A patent for the Thor washing machine, designed by Alva J. Fisher, was issued three years after its initial invention. Thor was powered by a small electric motor and equipped with a self-reversing gearbox to ensure that the clothes were not compacted into a solid mass.

10 AUGUST

1793 The Musée du Louvre, the world's largest art museum, was officially opened in Paris, France.

11 AUGUST

2003 The Blaster worm, also known as MSBlast or Lovesan, began to spread on the Internet, infecting Windows XP and Windows 2000 computers. The primary symptom of the worm was the crashing of the Remote Procedure Call service, which would trigger the computer to shut itself down and reboot with an error message.

12 AUGUST

1927 "Wings", one of only two silent films - the other being The Artist in 2011 - to win an Oscar (Outstanding Picture 1929) for best picture, opened starring Clara Bow.

13 AUGUST

2008 American super-swimmer Michael Phelps won 3 gold medals, all in world record time, during the one day at the Beijing Olympics.

14 AUGUST

1880 After 632 years construction of Cologne Cathedral, the largest Gothic Cathedral in Northern Europe, was completed. Although work began in 1248 it was halted in 1473, unfinished. Work did not restart until the 1840s and followed the original medieval plans.

15 AUGUST

1877 Urban legend has it that this was the day "Hello" was first used as a greeting when Thomas Edison answered the telephone using it. Up until then the word hello had been used to attract attention ("Hello, what do you think you're doing?"), or to express surprise ("Hello, what have we here?").

16 AUGUST

2017 Researchers from the University of Cambridge, United Kingdom, suggested that the Chilesaurus may be the so-called "missing link" between the Stegosaurus and the Tyrannosaurus.

August in History

continues from page 63

17 AUGUST

2008 The United States team (Michael Phelps, Aaron Peirsol, Brendan Hansen and Jason Lezak) won the 4 x 100m medley relay at the Beijing Olympics. This made Phelps the first person to win eight medals at one Olympic Games, breaking Mark Spitz's 1972 record of seven.

18 AUGUST

1783 A huge fireball meteor is seen across Great Britain as it passes over the east coast. This was the 1783 Great Meteor, an unusually bright bolide at a time when such phenomena were not well understood.

19 AUGUST

1960 Korabl-Sputnik 2 (meaning Ship-Satellite 2), also known incorrectly as Sputnik 5 in the West, was a Soviet artificial satellite, and the third test flight of the Vostok spacecraft. It was the first spaceflight to send animals into orbit and return them safely back to Earth. This flight paved the way for the first human orbital flight, Vostok 1, which was launched less than eight months later.

20 AUGUST

1912 Stainless steel was cast for the first time. In 1907 Harry Brearley was in charge of the Brown-Firth Research Laboratory in Sheffield, England. The lab had been investigating ways to eliminate rust in gun barrels, when by accident, Mr Brearley noticed a discarded steel sample from an earlier test that had not rusted; the result was a chrome alloy steel, much more rust resistant than previously seen. Two months later, on August 20, 1912, stainless steel was cast for the first time.

21 AUGUST

2017 London's Palace of Westminster's Big Ben (the iconic bell) sounded the hour for the last time Monday before it went silent for nearly four years of repair work. After 12 deep bongs at noon (GMT), the bell began its longest period of silence since it first rang out in 1859 from its famous perch over the British Parliament.

22 AUGUST

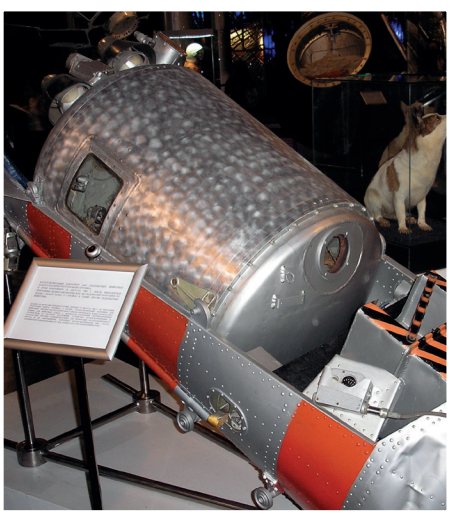
2016 Microsoft acknowledged that a Windows 10 update has stopped millions of webcams from working.

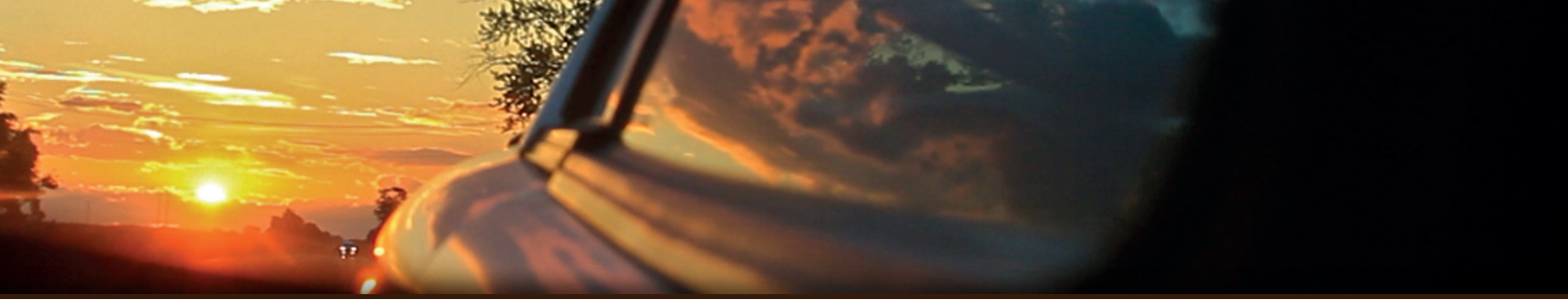
23 AUGUST

1966 NASA's Lunar Orbiter 1 took the first photo of Earth from the moon's orbit. The photo was transmitted to Earth by Lunar Orbiter I and received at the NASA tracking station near Madrid.

24 AUGUST

2006 Pluto was declassified as a planet by the International Astronomical Union (IAU) following a vote at their 10-day General Assembly in Prague, Czech Republic. It was given status instead as a "dwarf planet," on account of its small size (smaller than the Moon) and highly elliptical, tilted orbit





which overlaps with that of Neptune. However, only 424 of 2,700 astronomers who remained in Prague for the last day of the meeting took part. Those who voted were about only 4% of the world's 10,000 astronomers.

25 AUGUST

1835 The first of six Great Moon Hoax article was published in The New York Sun, announcing the discovery of life and civilization on the Moon. These articles described fantastic animals on the Moon, including bison, goats, unicorns, bipedal tail-less beavers and bat-like winged humanoids ("Vespertilio-homo") who built temples. There were also trees, oceans and beaches. These discoveries were supposedly made with "an immense telescope of an entirely new principle." Eventually, the authors announced that the observations had been terminated by the destruction of the telescope

26 AUGUST

1959 The Morris Mini-Minor was introduced by the British Motor Corporation. The car, popularly known as the Mini, remains successful over five decades later. It became a landmark in automotive design because it was only 10 ft long yet seated four passengers.

27 AUGUST

1999 The final crew of the Russian space station Mir departed the station to return to Earth. Russia was forced to abandon Mir for financial reasons.

28 AUGUST

1845 Founded by inventor Rufus Porter, the first issue of Scientific America was published. Unlike today, under the logo and scrolling leaves and flowers, a slogan appeared: *"The Advocate of Industry and Enterprise, and Journal of Mechanical and Other Improvements."* The biweekly broadsheet focused mostly on patents and advice for inventors.

29 AUGUST

1997 Netflix was launched as an internet DVD rental service. Now the company's primary business is its subscription-based streaming service which offers online streaming of a library of films and television programs, including those produced in-house.

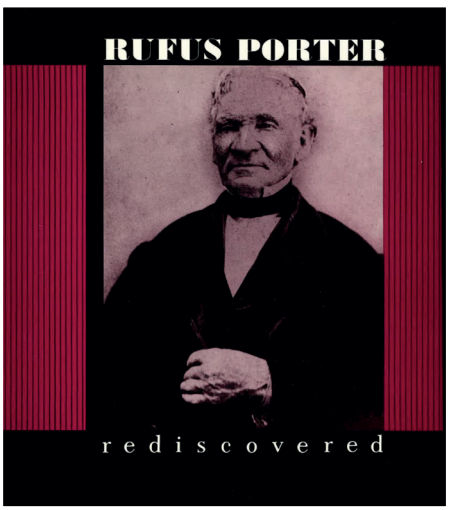
30 AUGUST

1831 Faraday first demonstrated the transformer.

31 AUGUST

1955 William G. Cobb of the General Motors Corp. (GM) demonstrated his 15-inch-long "Sunmobile," the world's first solar-powered automobile, at the General Motors Powerama Auto Show held in Chicago, Illinois.

Today, more than a half-century after Cobb debuted the Sunmobile, a mass-produced solar car has yet to hit the market anywhere in the world. WN



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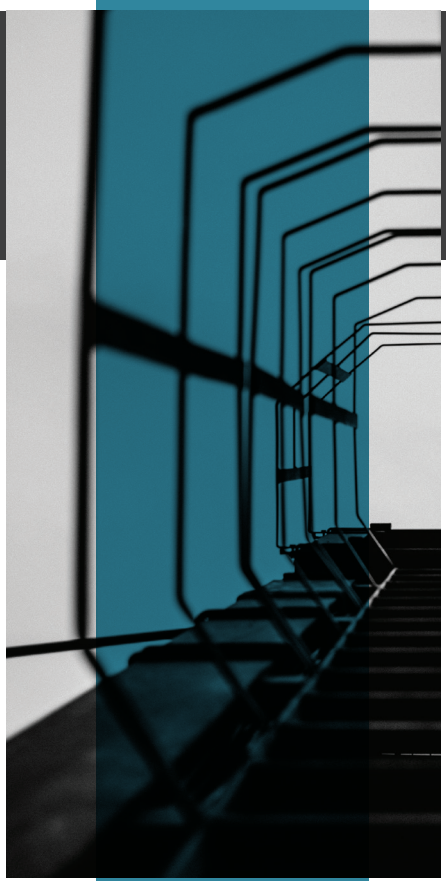

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TRACK 5: EMPOWER
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