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LIGHTNING

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

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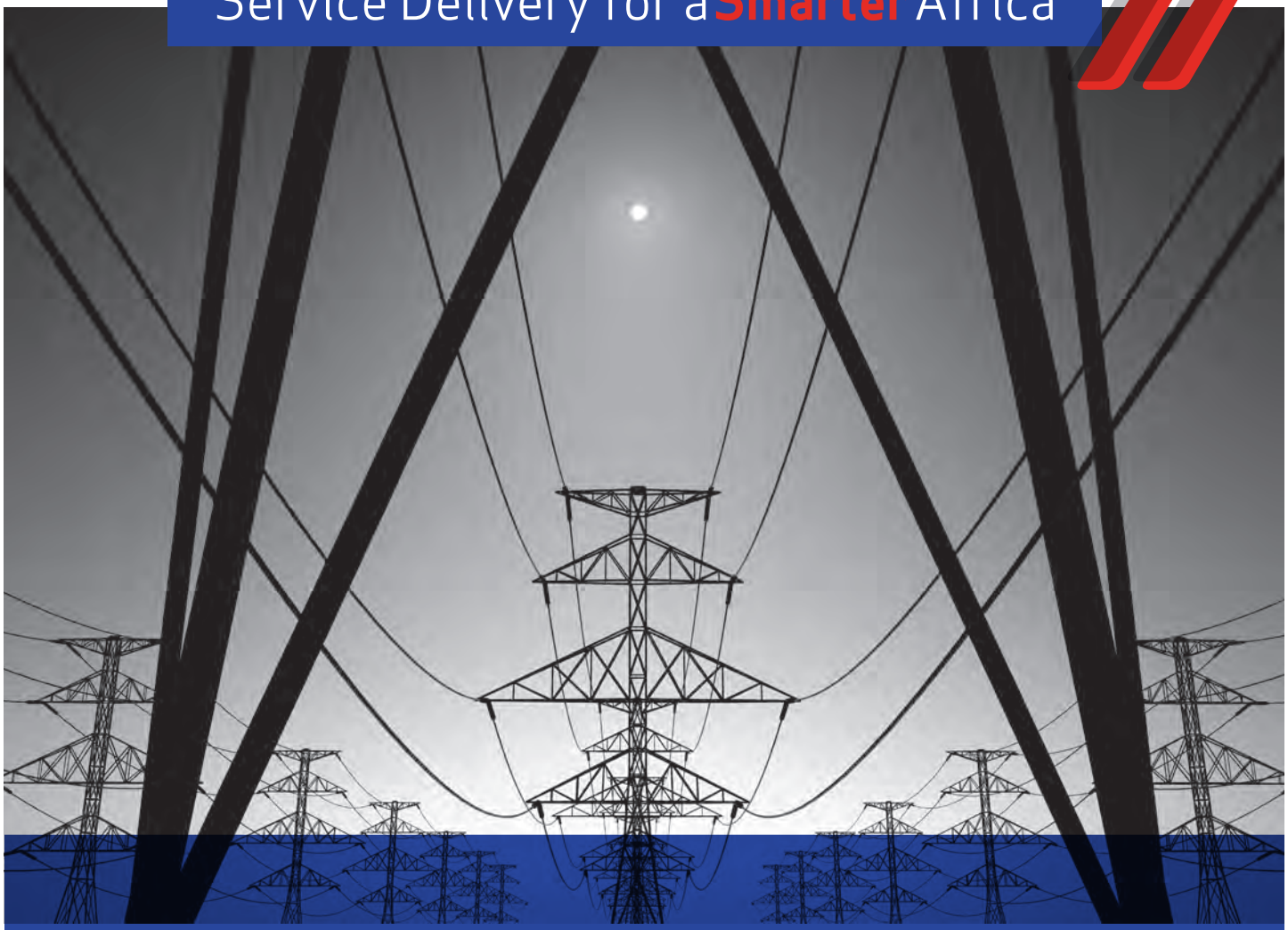
Service Delivery for a Smarter Africa



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WE'RE PROUD TO WELCOME THIS YEAR'S SPEAKERS

PROF MASSOUD AMIN

KEYNOTE SPEAKER

Professor Amin holds the Honeywell/H.W. Sweatt Chair in Technology Leadership at the University of Minnesota, and is also the Director of the Technological Leadership Institute (TLI) at the University.

Professor Amin is an expert in smart grids, dynamical systems and controls, critical infrastructure security, pivotal technologies, global S&T development, IP valuation and strategy, and teaches a number of courses both at undergraduate and post graduate level. His research focuses on two areas: 1) Global transition dynamics to enhance resilience, security and efficiency of complex dynamic systems, including national critical infrastructure for interdependent energy, computer networks, communications, transportation and economic systems; 2) Technology scanning, mapping and valuation. He pioneered research and development in smart grids, and since 2003 has given four briefings at the White House and nine Congressional briefings on smart grids

VALERIE-ANNE LENCZNAR

PLENARY SPEAKER

Valerie-Anne Lencznar is a communication (CELSA-Paris IV Sorbonne) and Executive MBA (HEC) graduate. She has worked and led as a Communication Director in various public structures. She joined the Energy sector 15 years ago as the Communications Director of a nuclear generation power plant, and she has worked on the expansion of the EDF Group in Poland and Hungary. Between 2009 and 2015 she was General Secretary of Inelfe, the Franco-Spanish joint venture dedicated to the construction of the underground electricity interconnection between Perpignan and Figueras, a world first, with a total budget of 700 million Euros. This project proceeds the setting up of smart grid transportation in Europe.

REJI KUMAR PILLAI

PLENARY SPEAKER

Reji is the President of the India Smart Grid Forum and Chairman of the Global Smart Grid Federation. He is an internationally renowned expert with over three decades of experience in the electricity sector in diverse functions covering the entire value chain across continents. He is spearheading a mission to leverage technology to transform the electric grid in India and light every home at affordable cost through sustainable developmental models. Reji played a pivotal role in the formulation of the Smart Grid Vision & Roadmap for India and the launch of a National Smart Grid Mission by the Government of India.

co-hosted by Eskom

contents

FEATURES

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Dear Reader

With our Lightning season around the corner in South Africa, I thought it apt to theme the August issue of **watt**now - Lightning.

The first feature article, "Lightning & Surge Protection Systems for Free Field Solar Farms" (pg 20) has determined that lightning is the biggest cause of damage to solar farms.

Then, on page 28, we look at lightning from a different angle - from space. Read how scientists detect lightning from space.

Page 34 shares with us how serious lightning really is, and shares some facts about Lightning you didn't know.

On page 44, Darryn Cornish, one of two winners of the 2017 IEC Young Professionals shares with us his winning essay - "The necessity of the IEC in my work".

Dudley Basson takes an in-depth look at 3D printing - where printing started and to how the technology has evolved in something totally mindboggling! Read this article on page 48.

The 2017 SAIEE SmartGrid Conference is a few weeks away. We have a fantastic line up of keynote speakers, trend talkers, innovation and plenary speakers and much more. As it stands, we have 30 seats available. Please book and pay for your spot now - before you are left disappointed. For more info, visit www.saiee-smartgrid.co.za to register.

Herewith the August issue, enjoy the read!

Minx

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


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JACOB MACHINJIKE
2017 SAIEE PRESIDENT

August month is very special as we celebrate women's month. I would like to wish our members and readers a happy month of August, especially to all the women, in our lives. The August's theme our wattnow magazine is Lightning. This is a phenomenon that nature provides, an enormous release and transfer of electrical charge, mostly during thunderstorms with some "wild" rebels.

While much of the lightning mechanism is now understood, a certain amount of mystery will always remain. Its existence poses a significant risk to many in South Africa and Africa by threatening power systems, residential homes, industrial complexes, manufacturing, agriculture, sports and recreation, schools, mining, forestry, the transport networks and, most importantly, exposed and unprotected people and animals.

There are extensive studies relating to lightning and its effects by various research institutes, laboratories, universities, manufacturers and providers of lightning protection products and services both within South Africa and around the world. The ELPA (Earthing and Lightning Protection Association) South Africa was launched in June 2017. Its goal is to bring the South African lightning protection industry into the mainstream of "best practice" to support our communities and industries. The South African Weather Service (SAWS) has more than eleven (11) years of reliable lightning data, and over 364 million "total lightning" records (constituting between 21 million and 38 million discharges per annum) across greater Southern Africa to support the new officially released Lightning Ground Flash Density (GFD) map. This map and data have now replaced the aged Council for Scientific and Industrial Research (CSIR) ground flash density map. The new map was launched at the Earthing Africa Symposium at the beginning of June 2017 and will soon be integrated into all relevant standards. All parties addressing lightning as a risk need to make the necessary enquiries to assess actual lightning risk. The resolution reflects detail to that of a large sport complex.

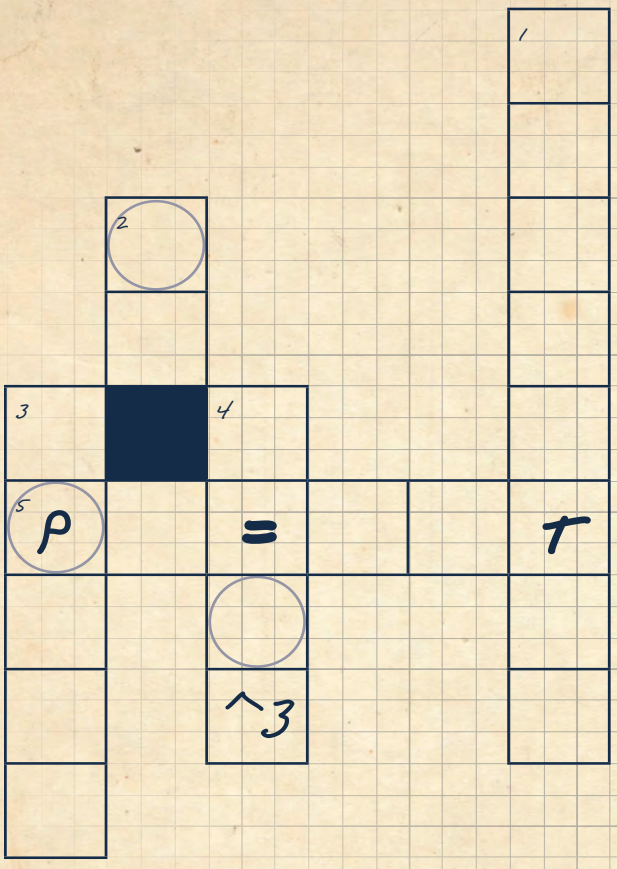
SAIEE has recently established a Lightning Protection Section. This section is an important part of the inner workings of SAIEE, as it draws together members and other specialists with an interest on furthering the understanding of lightning, its effects and coming up with solutions to the benefit of human kind.

An African effort is under way to bring sound lightning immunity practices to all countries across Africa, and we are moving to establish a branch in South Africa; not only as support to the other African countries but to ensure that they gain from our leveraged knowledge to cost effective solutions not constrained by superstition. This includes meeting people at their cultural place of safety and respecting each community's norms. The affiliation is ACLE-Net (African Centres for Lightning and Electromagnetics – Network) and we will see an ACLE-Net South Africa soon.

Lightning Interest Group for Health Technology and Science (LIGHTS) is still active and some decisions need to be made in relation to the new developments of ACLENet in order to remain relevant. The future is exciting as we hope to see all tertiary institutions considering some form of lightning awareness programs. Wits University is looking to make a mark not only as a Centre of Excellence but as a mentor support role for skills development across all interested and contributing universities in South Africa.

It's time to consolidate and work together to meet the needs of Africa.

J Machinjike| SAIEE President 2017
Pr. Eng | FSAIEE



DOWN

1. The formula p=m•v is used to calculate.
2. The SI Unit for Pascals (the derived unit to quantify internal pressure).
3. The letter S in S=d/t is used to notate which scalar quantity?
4. Formula for the volume of a cube.

ACROSS

5. The equation stated by Émile Clapeyron in 1834 as a combination of the empirical Boyle's law, Charles' law and Avogadro's Law commonly known as the ideal gas law.

SAIEE celebrates Women's Month

SAIEE Staff and Council Women from left:
Gerda Geyer, Sy Gourrah, Sue Moseley, Prudence Madiba, Amelia Mtshali, SAIEE President Jacob Machinjike, Celeste Pretorius, Androzette Muller, Joanne Griffen, Ansie Smith, Connie Makhalemele, Dudu Madondo, Alice Makhado, Lerato Mulovhedzi and Minx Avrabos.

At the August Council meeting, SAIEE President, Jacob Machinjike celebrated Women's month with the SAIEE Council and SAIEE Staff.

He gave each woman a handbag which included a scarf and goodies.

Machinjike and the SAIEE Council wish our female members a wonderful Women's Month. *"South Africa commemorates Women's Month in a tribute to the thousands of women who marched to the Union Buildings on 9 August 1956 in protest against the extension of Pass Laws to women"* he said.

"As a country, and an Institute, we can look back with pride at our journey over the last 100 years, and look forward to a better future. The journey, however, continues and every positive milestone along the way is but another step to ensure that every women and girl is empowered.

As a valued member, we salute your contribution to the engineering industry. Thank you!" he concluded.

We would like to thank our sponsors, Actom and Dehn Africa for the beautiful handbags and gifts. We will never forget.

SAIEE/AMEU signs MoU

At the August Council meeting, SAIEE President Jacob Machinjike signed a Memorandum of Understanding together with the President of the Association of Municipal Electricity Utilities (AMEU), Moferefere Tshabalala, in the presence of the SAIEE Office Bearers and delegates from the AMEU.

Finfind CEO JOINS RANKS OF TOP INTERNATIONAL WOMEN

As Women's month - both celebrate and highlight the role of exceptional women across South Africa, Finfind is proud to announce that the organisation's CEO - Darlene Menzies from Kwa-Zulu Natal - has been selected by CoCreateSA as one of the top 50 inspiring women in this country.

Chantal Louw of CoCreateSA said *"the caliber of women is amazing and the project has reached so many different fields,"*. She added that that the women nominated are not only professionals but are people who are at the top of their respective games and who inspire others to be more and to give more back to their communities and businesses. With the complexity of the landscape considered and selections made based on social media, curriculum vitae's and on what these women deliver, Darlene's high scores from all judges and stand out performance amongst the country's top achieving women is impressive. With this award, Darlene joins the ranks of the many remarkable women in South Africa who fill the important part of role model for our girls and women to aspire to and look up to, showing them what can be achieved – especially in Technology.

Darlene, a native of Durban in KwaZulu Natal, is the founder of Finfind, the leading online access to finance solutions for entrepreneurs. Officially launched in 2015, Finfind aims to match SMEs who are seeking finance with appropriate lenders. Being selected by CoCreateSA as one of the top fifty inspiring women in SA is only one of Darlene's achievements - from opening her own businesses to sitting on the board of the Durban Chamber of Commerce.

The SA leg of Inspiring Fifty made its selection based on 252 nominees from head masters to entrepreneurial leaders. 29 are academics; 76 hold C-Level positions; 87 are founders of technology or innovation organisations; 3 are in government/ politicians, 2 are analysts; 37 are key influencers and 18 hold other roles in the relevant sectors.

Bonnie Horbach, Consul General of the Kingdom of the Netherlands who has adopted the concept of selecting role models for girls and young women believes: "These women are inspiring role models for the future; Inspiring Fifty South Africa allows us to create a platform for them in technology, showing our girls that they can do the same."

Darlene Menzies
CEO | FinFind

A wonderful sentiment for a country so committed to celebrating its women for their inspirational leadership and contribution to South Africa.

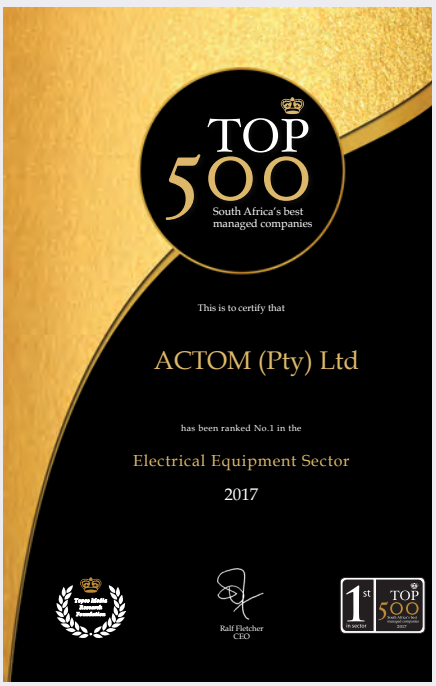
ACTOM wins Electrical Equipment sector 'Top 500' Award

ACTOM was recently named – for the second year in succession – as Top Performer in the Electrical Equipment sector in the Top 500 Companies Awards in South Africa for 2017.

The Awards, organised by Topco Media, publishers of the business-to-business publication Top 500, were announced and presented at the Awards function staged at Melrose Arch, Johannesburg, marking the ninth successive year of the existence of this prestigious competition and this year marking the ninth edition of the Top 500 South Africa's best-managed companies.

The key criteria by which the five top performing companies in each of a total of 100 different sectors are selected each year are financial performance, empowerment, policy and commitment and alignment to government's mandate centred around skills development, CSI enterprise development and various other differentiators.

The assessment and selection of candidates for the Top 500 Companies Awards are done by Topco's research department in conjunction with the University of Cape Town's Development Policy Research Unit, which set up the rigorous criteria for organisations that see themselves as being among South Africa's best-managed companies.



WATTSUP

DEHN Africa pays tribute to local partners at annual awards ceremony

The DEHN Africa Team.

Lightning and surge protection solutions provider, DEHN Africa has once again acknowledged local distribution partners, recently awarding top associates at its fourth annual African partner awards ceremony, which was held at the Randpark Golf Club in Johannesburg.

The big winner for the evening was Universal Lightning Protection Services (ULPS), which received the title of *"Best Performance Overall"* for the second consecutive year. The title of *"Project of the Year"* went to Pontins, for their work on the Tswalu Montlhopi Game Lodge. Webb Industries, a division of Jasco Trading, took home the trophy for the *"Most Up and Coming Partner",* while ElectroMechanica and Electro Tech were named as the *"Reseller of the Year"* for South Africa and the Southern African Development Community (SADC) region respectively.

Having held its very first Partner Golf Day earlier the same day, DEHN Africa also handed out several additional awards for the games played, with Seath Scowby of ULPS getting the nearest to hole 8, Dirk van Staden, also from ULPS, winning the prize for the longest drive, DEHN Africa's Etienne Gerber being placed as closest to hole 17, and Tatenda Gora of DEHN Africa having endured the longest day.

As well as thanking all partners for their commitment over the past year, DEHN Africa Managing Director, Alexis Barwise gave attendees an update on the internship programme with Wits University, where he appealed to local businesses to assist in providing second year electrical and mechanical engineering students with industry experience during their six months of practical training.

Barwise also touched on the global DEHN + SÖHNE 2020/2025 vision and how this would be adapted locally, before bidding farewell to all present prior to his departure from South Africa's shores to join the DEHN + SÖHNE team in Neumarkt, Germany, as director AMEA.

EOH Signs Schneider Electric Software Deal

EOH announces it is the official Southern African distributor for world-class industrial software solutions provider Schneider Electric Software, strengthening its industrial technologies portfolio.

The Schneider Electric Software portfolio, which includes; Aquis, Avantis, OASyS, Ampla, Citect SCADA, ClearSCADA, SimSci and Wonderware, improves productivity and profitability for production, manufacturing and infrastructure industries.

Schneider Electric Software has a longstanding relationship with EOH, through Wonderware Southern Africa, a partner of the EOH group, having supplied and supported the Wonderware suite of products since 2003. As a result, EOH was the logical choice to take on the distribution of Schneider Electric software in Southern Africa because of its existing focus on, and technical expertise in, the mining, manufacturing and infrastructure sectors.

"Bringing Wonderware and the rest of the Schneider Electric Software business under one EOH roof in South Africa is great news for our customers," said Deon Barnard, MD of Wonderware Southern Africa. *"We are proud to be a part of the depth and breadth of proven solutions, backed by some of the most knowledgeable people in the business. This is another milestone in the elimination of artificial boundaries between solutions and their functional application in the field, a great benefit to our customers who have to do it all."*

Marc Ramsay, VP Schneider Electric Software, said: *"Partnering with EOH to support our software portfolio and collaborate on sales, will improve the service tocustomer experience of software customers and enhance the breadth of our software offering.*

AfricaCom 2017 accelerating Africa's journey towards the 4th Industrial Revolution

AfricaCom was recently launched at an informal function held in Rosebank, Johannesburg. The event kicked off the celebrations for the 20th anniversary of what is Africa's largest, most influential, technology, media and telecommunications (TMT) conference and exhibition.

A lively panel discussion involving some of the most progressive thought leaders and commentators on the continent started the proceedings. Manny Teixeira, MTN; Luke Mckend, Google South Africa; Rapelang Rabana, Rekindle Learning; Elizabeth Migwalla, Qualcomm and Gustav Praekelt, Praekelt Consulting led the debate, which centred on what might be in store for the architects of Africa's digital future. This set the scene for the event, due to take place at the Cape Town International Convention Centre (CTICC) from 7 – 9 November 2017.

"2017 is a landmark for AfricaCom. Over the past two decades, we have grown from being a purely telecommunications-focused event, to a broad digital communications show now hosting the foremost group of influencers involved in every aspect of the African digital ecosystem," explained Tom Cuthell, Events Organisor, KNect365.

"As the digi-sphere continues to expand and impact every aspect of our personal and professional lives, AfricaCom has grown in scope to create a broad platform for everybody involved in powering the digital economy in Africa. I am delighted to share some of the fresh developments that will continue to accelerate Africa's digital transformation anchoring it for the future of the 4th Industrial Revolution."

Some of the new areas include:
The Technology Arena - an exhibition hall dedicated to mapping Africa's journey through the Fourth Industrial Revolution.

This will include:
• AfricaCom 20/20 - the centrepiece and base of the 20th anniversary celebrations. A vibrant, interactive, buzzing place to see digital solutions from top innovators; interact with next generation technologies in specially designed demo pods; and listen to thought provoking dialogue around 'providing clarity of vision on future tech trends'.

• The new Innovation Stage – that will showcase ICT solutions affecting the converging TMT industries in Africa. Lively debate and discussion on topics such as eHealth and ICT4D, with quickfire presentations, and product pitches will be the order of the day.

The Technology Arena will be the new home for the AHUB – AfricaCom's matchmaking centre for start-ups and investors; and TV Connect Africa – the confluence of broadcast, telecoms, content and new media experts in Africa, intent on developing commercial models for ITC across digital Africa.

Three days of networking, thought provoking content and amazing tech, will also showcase new opportunities in Artificial Intelligence, the Internet of Things (IoT), Big Data, FinTech, Blockchain, digital skills and more.

As always, the calibre of 400 speakers and 400 exhibitors, addressing attending delegates, is a major drawcard. Conference tracks such as Visions for Africa Keynotes, SDN and NFV, Mobile Finance and eCommerce in Africa, Enterprise ICT, and Connecting Africa, as well as LTE Africa, will deliver the latest advances in their respective areas. Some of the luminaries to present their insights are; Herman Singh, Group Chief Digital Officer, MTN; John Momoh (OON), Chairman & CEO, Channels Media Group; Is'haq Modibbo Kawu, Director General, National Broadcasting Commission; Joseph Hundah, CEO, Econet Media.

The Annual AfricaCom Awards will once again highlight leaders in their respective fields and Cuthell reminded guests that entries for these industry heavyweight acknowledgments were also now open.

Automation - The way to go

Speciality cable manufacturer, Helukabel, is gaining global recognition for its wide range of automation cables that have been specially designed for optimal performance on sophisticated automation equipment.

Automation cable systems are unique in that they require precision manufacture that not only ensures the total integrity of information relayed and current transported, but also need to be durable and reliable to handle the high mechanical stress and repetitive movements that is often associated with automated processes.

In South Africa, there is an increased move towards automation as stricter standards require ever tighter tolerances, while the market place required higher volumes and keener pricing. It is therefore essential that cabling systems, which are effectively the lifeblood of automation project, is of the highest quality and is fit-for-purpose.

WATTSUP

Solar plants – managing the lightning risk

Solar plants, particularly (but certainly not only) large facilities such as utility-scale PV plants, present particular challenges in respect of lightning protection.

Engenamic, with their team's leading specialist professional engineering expertise in the field of lightning safety and lightning protection, observe that there are particular general characteristics of such sites and applications, that contribute to their exposure and vulnerability to the deleterious effects of lightning.

Engenamic CEO, Ian McKechnie noted that: *"it presents a complex site and application environment, and this complexity impacts directly on the broad-based risks and engineering (and other) management challenges associated with lightning safety and lightning protection".*

Engenamic noted that these are typically large and geographically extended sites, with factors such as the extensive interconnected electrical and electronic equipment. System elements adding to the complexity and challenges to be addressed and managed in a holistic and integrated manner.

Plant equipment is relatively exposed to both direct strikes and to the induced effects of the electromagnetic fields associated with lightning strikes. These fields can potentially affect and damage buried services (such as cables) as well as above-ground equipment. The damage to buried services (such as insulation damage) can also potentially only become apparent at a later stage ('latent damage').

The nature and characteristics of such plants required a careful consideration of the risk assessment methodology, including the judicious use of risk areas or zones as appropriate.

"The nature of such plants and the associated risks emphasises the need for an effective, holistic lightning protection solution that is coherent across all aspects," commented McKechnie.

Ian McKehnie
CEO | Engenamic

Important aspects and elements of such a solution include, direct strike protection, site-wide equi-potentialisation, and the careful, considered and consistent definition and application of lightning protection zones.

Energas Technologies appointed to design and supply fuel gas receiving package for Kpone in Ghana

A new power plant, Kpone Independent Power Plant (KIPP) in Tema, Ghana, will be independently owned by Cenpower Generation Company Limited (Cenpower) to provide safe, secure and reliable electricity supply to Ghana.

The power plant will comprise a multi-shaft combined cycle configuration comprising two gas turbines, two heat recovery steam generators and a single steam turbine, and it will have a nominal installed capacity of approximately 350 MW. Power generated by the plant will be supplied directly to the Electricity Company of Ghana (ECG), the main distribution utility through the Ghanaian grid. The plant will be designed to be fuelled by any one of three fuel sources, that is, natural gas, distillate fuel or light crude oil.

HP van Huyssteen, Energas Technologies Project Engineer comments, *"Energas' scope was to provide temperature and pressure controlled gas to the power plant. The incoming gas will be filtered to remove any droplets and particles larger than one micron before the gas is passed through a sophisticated gas meter. The gas is thereafter heated in a waterbath heater that uses a fraction of the piped gas as a fuel source before the pressure is reduced to within the limits as required by the power plant's gas turbines. Pressure control is achieved by using fast acting precise dual regulators. It is imperative that the gas is maintained above its due point to avoid serious damage to the gas turbines. A unique aspect of the entire fuel gas receiving package, is that it is built on skids (including the waterbath heaters) to facilitate and shorten installation time on site and a dual run layout provides the required redundancy."*

One of the challenges Energas experienced was to fit the entire fuel gas station into a tight area and to design the station in such a manner that site installation can proceed as smooth as possible. Dimensions had to be tightly controlled, as skids made in South Africa and Germany has to fit precisely after installation.

Energas' fuel gas receiving package was delivered at the port of export at the end of November 2016. The work involved piping, structural, mechanical, process, electrical and software engineers and was successfully delivered by the required contractual delivery date, and within budget.

With many years of experience in the supply and support of products to large industries concerned with natural gas, Energas can supply a complete range of products to the various stages of gas production, transportation, distribution and storage.

This includes wellhead equipment, critical control and safety valves, pipeline valves, filter vessels, relief valves, meters, regulators as well as domestic gas regulating and safety equipment. Energas has been supplying equipment for metering and pressure reduction stations since 2001.

"With experienced consultants and reputable suppliers, Energas had the capability to deliver the entire project scope. It is imperative that the Energas portion of the plant operates very reliably, without much operator intervention due to the large distance that the plant is situated from South Africa. It is critical that these types of stations operate safely and successfully due to the potential hazards involved in the handling of high pressure flammable gas," Huyssteen concludes.

Factors including rapid economic growth, the expansion of the electricity supply network and the initiative and encouragement of the Ghanaian Government to develop industries and services, contributed towards opening the door for the private sector to participate in the building of new power plants, such as the KIPP in Tema. The power plant is due for completion in 2017 and will provide permanent employment to the operating personnel.

AURECON LAUNCHES NEW APPROACH TO ENGINEERING IN AFRIKA

Global engineering and infrastructure advisory firm Aurecon is proud to launch its pioneering approach to engineering in Afrika, Afrikan Design Innovation (ADI), which focuses on fusing traditional technical skills with design thinking to find innovative solutions to the complex problems confronting Afrika. Centred on anticipating disruption, connecting the dots between various global events and developing human-centric solutions, Aurecon believes that ADI has the potential to revolutionise the way engineers approach Afrika's problems.

It's an approach that's already making a difference, with several case studies incorporating design thinking demonstrating its efficacy in developing targeted, relevant solutions which are readily championed by end users.

This impact will echo into the future as we develop a sustainable vision for Afrika.

Earthing and Lightning Protection Association (ELPA) kicks off first certification cycle

The recently launched Earthing and Lighting Protection Association (ELPA), created to protect consumers, establish a uniform interpretation of the codes of practice, and help to regulate and advise the lightning protection industry, has announced that the first set of ELPA examinations is set to commence in August 2017.

South Africa has over 24 million lightning strikes every year, bringing with this more than 500 lightning-associated deaths annually and a cost to the economy running into billions of Rands. The formation of ELPA has therefore been widely welcomed by numerous engineers, associations, universities, government bodies, insurance bodies and the general public.

ELPA is also helping to take South Africa's prominence in the global lightning protection arena another step forward, says National Director Trevor Manas. He says, *"It is ELPA's stated intention to co-ordinate the dissemination of knowledge for lightning industry practitioners, consumers and the general public; communicate holistically around the potentially deadly dangers presented by lightning; and assist with advice on over-arching legislation to guide all concerned parties.*

With the very real danger not only of significant damage to property but also the loss of life, there is a serious need to upskill those who carry out lightning protection installations, so that they understand the science behind what they are doing. Working with ELPA-approved designs for lighting protection systems (LPS) as well as ELPA-accredited installers brings with it real benefits that will have a widespread positive effect for the lightning protection industry, consumers and even the insurance industry," he states.

Manas clarifies that ELPA intends to play a role in improving the technical competency within the industry, in particular that of installers, designers and assessors. He adds, *"Our plans to assist with certification and compliance will be united under one umbrella body that brings together experts and interested parties from various areas of the lightning protection arena."*

The benefits of using ELPA-accredited designs and installers include the following:

- ELPA offers an approval service for LPS design drawings.
- All ELPA-accredited installers are properly trained and have passed the ELPA examination with at least an 80 percent pass mark.
- ELPA carries out random inspections of LPS installations by accredited ELPA inspectors.
- ELPA offers a guarantee of all installations carried out by accredited installers such that, if sub-standard workmanship or non-compliant installations are found, the association will fix the LPS installation to comply with the standards.
- ELPA offers independent evaluation of installations and designs, whether these installations or designs are completed by members or not.
- ELPA will provide the details of ELPA-accredited designers, installers and assessors to engineers or any other interested person on request.

Manas explains that there are three different types of ELPA memberships, namely:

- Ordinary: These are members who will be accredited as installers, designers and inspectors / assessors.
- Engineering / Associate Members: These members are engineers and would have access to technical assistance from our team of experts.
- Affiliate Members: This is the manufacturer's membership; affiliate companies would be on the ELPA list of preferred / approved compliant component suppliers.

"An ELPA guarantee on LPS work will assist the insurance industry, in that we will commit to fixing sub-standard work at our cost if an installation that was guaranteed by ELPA is later found to be non-compliant. In this way, using an ELPA-certified installer would provide peace of mind, as will the guarantees the association provides on a design, even before installation.

We encourage all those who would like to be trained and accredited to contact ELPA for our training facilitators. The formal establishment of ELPA is an important addition to the standard of safety in the South African lightning and protection industry, and we look forward to this significant first set of examinations and also moving on thereafter," Manas concludes.

For more information, visit www.elpasa.org.za.

ELPA
EARTHING AND LIGHTNING PROTECTION ASSOCIATION

RELIABLE DETECTION OF OBJECTS AND FILL LEVELS

Leuze's range of optoelectronic and inductive switches with capacitive proximity switches make it possible to apply a solution for all detection requirements from a single source. Using innovative technology, these sensors are able to reliably detect and monitor fill levels and detect objects through packaging materials.

Available from Countapulse Controls, leading supplier of specialised sensing solutions, the contactless, wear-free switches are resistant to electromagnetic influences, interference and contaminants in the air such as dust.

Facilitating optimum flexibility in applying this technology, the capacitive switches are available in a cylindrical or cubic design, and in embedded or non-embedded versions. This allow for a wide range of mounting options.

Designed using semiconductor technology, these Leuze switches offer a long life expectancy, regardless of the detection and switching frequency. And the new generation sensors make contactless detection of many different objects and media possible, regardless of the shape.

The Leuze switches are particularly suitable for detecting objects in harsh and dirty environments due to their IP67 housing. Further, the ability to "see through" certain materials allows these switches to be used in food and beverage and packaging industries where it is possible to detect products in outer packaging and behind container walls. These sensors are also ideal for accurately checking fill levels and monitoring these for completeness.

Johannesburg-based Countapulse Controls has an in-depth understanding of the application of absolute rotary encoders and is able to assist the market in selection of the best fit solution for a given application.

Introducing fixed-wireless technology for making telephone calls

Huge Software and Technologies - the provider of full suite telephony services to corporate organisations and residential homes – has successfully developed its own fixed-wireless router for making telephone calls and is fittingly calling this device the Huge Router.

The Huge Router is a device specially developed to carry calls to the radios of various mobile network operators in conjunction with a SIM card. It is able to completely emulate a standard telephone line, allowing it to make outbound telephone calls and receive inbound telephone calls.

Resolution Circle, a subsidiary company of the University of Johannesburg, was briefed to manufacture the printed circuit boards (PCBs) of the Huge Router. Engineers at Resolution Circle agreed to provide Huge Software and Technologies with a turnkey solution, including the manufacture of the printed circuit boards, the assembly of the Huge Router and the packaging. The Huge Router has already been installed at clients.

According to Dr Wiehan Le Roux, Group Senior Manager, Engineering at Resolution Circle *"It takes us approximately 30 minutes to assemble and package the Huge Router – 12 minutes to surface mount the components onto the PCB, 5 minutes to inspect the surface mount quality, 10 minutes to test the PCB and assemble the router and 3 minutes to package it."*

A Business Development Manager within the Huge Group of companies, Rajen Pillay, says, "The Huge router replaces fixed line infrastructure over the last mile and eliminates the risk of the negative impact of copper cable theft, which is a common occurrence in South Africa. It made perfect sense for us to acquire the intellectual property behind the Huge Router, which we did over a year ago, and to perfect it in-house with the assistance of Resolution Circle. This has given us a double benefit: first, complete control over our last mile network and second, favourable cost reductions.

WATTSUP

SAIEE CGC PANEL DISCUSSION: WOMEN IN MALE-DOMINATED INDUSTRIES

In commemoration of women's month, the SAIEE Central Gauteng Centre (CGC) hosted a Panel Discussion on Women in Male-Dominated Industries, at the University of the Witwatersrand, on the 11th of August 2017.

The panel was co-moderated by Tshego Cornelius, the SAIEE CGC Chairperson, and Michelle Govender, SAIEE CGC's Treasurer.

The Panelists included:

- Lebo Maphumulo, Pr Eng, MSAIEE, an Eskom Corporate Specialist in Line Engineering Services, who serves on the ECSA Council;
- Sinenhlanhla Dlamini, a Business Development Manager at Argon Asset Management, an owner of a luxury women's brand, Clad Chic, who also serves on the Council of the University of Johannesburg;
- Refilwe Buthelezi, Pr Eng, MSAIEE, an Automation Asset Manager at Rand Water who is a Council member of both the SAIEE and ECSA;
- Dr Dede Tonyane, a medical Doctor, a Registrar in Psychiatry and an Aerospace Physician;
- Amelia Mtshali, Pr Tech Eng, SMSAIEE, an Senior Manager in Power Delivery Engineering: Design Base and Operating Unit Support, who is Council member of both the SAIEE and ECSA;
- Baeletsi Tsatsi, a writer, facilitator and storyteller, who hosts monthly shows at the P.O.P Art Theatre in Maboneng, Johannesburg;
- Prudence Madiba, Pr Eng, SMSAIEE, a Senior Manager for Electrical, and Control and Instrumentation department at Eskom, who is a Council member of both the SAIEE and ECSA;
- Makgola Makololo, an Electrical Engineer and Acting Deputy Director General for Energy at the Department of Public Enterprises.

The panelists shared their personal experiences and challenges, as well as how they overcame and continue to overcome these challenges. The importance of mentorship and continued discussion on challenges faced by women in these male-dominated industries was emphasized by the panelists.

The audience was also given an opportunity to engage with the panel, which resulted in a suggestion that such or similar discussions be held regularly and not necessarily in August (Women's Month), as this may encourage greater participation from male counterparts.

The discussion and the event was recorded by Varsity TV, a student focused, campus based television channel and will soon be available on SAIEE CGC's YouTube channel. More information on the event may be viewed on SAIEE Central Gauteng Centre's Facebook page (www.facebook.com/saieecgc).

IITPSA marks diamond anniversary with new initiatives, gala awards

The Institute of Information Technology Professionals South Africa (IITPSA) this year marks 60 years since its founding as the Computer Society of South Africa, and the professional body has never been stronger. Now with over 8,000 members, SAQA and international IP3 accreditation, as well as a range of well-established industry initiatives to its credit, the IITPSA is entering its 61st year with several new highlights and programmes planned.

IITPSA President Ulandi Exner says a key highlight for the Institute's 60th anniversary celebrations will be the IITPSA Annual President's Awards; this year to be staged as a diamond-themed gala banquet. In recent years, the awards ceremony has been a breakfast event, but the diamond awards in November promise to be a truly celebratory, 'glitzy' dinner affair, says Exner.

But the awards are just one of several new highlights as the IITPSA enters a new era of ICT, she says.

"During the past few years, we have significantly strengthened our membership and financial position, as well as achieving SAQA and international IP3 accreditation, one of the benefits of which is we are now able to carry out critical skills assessments for visa applicants."

A major milestone for IITPSA was the awarding of a comprehensive new bursary for IT students. *"With skills development and encouraging more women to enter the IT field as key focus areas for the Institute, we achieved a real milestone this year when we awarded our first bursary to a young woman studying ICT at Wits University. This bursary covers absolutely everything from tuition and accommodation to a laptop. Going forward, we will continue to award a bursary each year to a deserving first year student,"* Exner says.

IITPSA also awards a Women in IT bursary to third year students, and has stepped up its efforts to raise awareness of IT careers at schools and tertiary institutions. The Institute has also become more active in its computer programming scholarships, in addition to sponsoring the Applications Olympiad for the past two years. The IITPSA Foundation, a new CSI investment arm for promoting and sponsoring skills development initiatives, is also set to become a great deal more active in the year to come, she says. *"But of course, our raison d'ĕtre is to ensure the professionalism of the ICT sector and its practitioners, are involved anywhere and everywhere,"* says Exner.

Sudor Coal Installs Booyco For Safer Mining

In pursuit of the goal of zero harm in mining, and in compliance with recent safety regulations, Mpumalanga miner Sudor Coal has implemented a state-of-the-art proximity detection system (PDS) from market leader Booyco Electronics at its Weltevreden operation.

The underground coal mine near Emalahleni has three sections extracting the Number 4 Seam at about 60 metres below surface. The Booyco PDS system includes buzzers and flash units on mine personnel, as well as transmitters on continuous miners, shuttle cars and roof-bolters.

The system prevents dangerous situations by alerting both the pedestrian and the machine operator to each other's proximity; an audible and visual alarm is triggered followed by retardation of the moving equipment, which is then brought to a standstill if no action is taken.

Petrus Vilakazi, underground engineer at Weltevreden, says the implementation of the system began in March 2016 and was rolled out across all three of the mine's sections over a period of about a year.

"We initially presented our implementation plan for a collision-avoidance system (CAS) to the Principal Inspector at the Department of Mineral Resources," says Vilakazi, "and this year we were able to report back to say the system was in place, in compliance with the new safety legislation."

Vilakazi says a vital part of the system's effectiveness is the buy-in of employees; it was therefore important to communicate the rationale for the PDS clearly with the underground employees to ensure that everyone understood why it was necessary and how it would improve safety.

Egbert Janse van Rensburg, Account Manager at Booyco Electronics and Petrus Vilakazi, Underground Engineer at Sudor Coal.

Anton Lourens, Booyco Electronics Managing Director, says the company's PDS has gained a reputation for helping mines to protect their most important asset: their people.

PV systems have been installed in Europe for the past 15 years. Over time, research has determined that there are various factors that cause damage and downtime to these PV systems. The single largest cause of damage to PV systems is, without doubt, lightning and induced surges.

This research was conducted in environments that have much lower lightning flash indexes than what we have in South Africa.

There is also a connection between the solar radiation, air humidity and the frequency of lightning discharges. The regional lightning flash index (strikes per km^2/year) and the location and size of PV plants will determine the risk of damage and downtime to the free field PV farm.

With the completion of Round 1 of the PV farm rollout in 2015, the astronomical amount of damage caused by lightning to various PV farms makes it clear that the proper lightning and surge protection measures are not being employed on these free field PV farms.

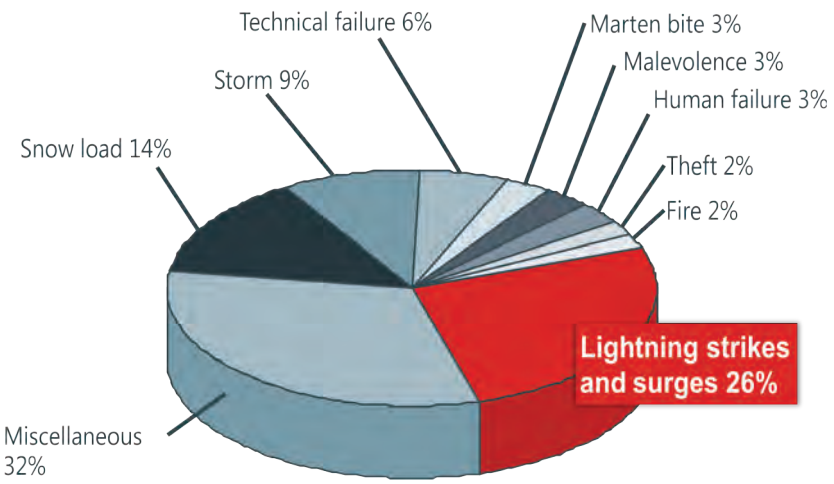
NEED FOR LIGHTNING PROTECTION

Damage to PV systems can be caused by both the destructive effects of a direct lightning strike as well as by inductive

Lightning & Surge Protection Systems for Free Field Solar Farms

or capacitive coupling as a result of the electromagnetic lightning field (in other words by nearby strikes). In addition, switching surges on the upstream AC system can also cause damage to PV modules, inverters, charge controllers and their monitoring and communications systems.

There are also much higher risks of fire due to the fact that a large portion of the Free Field PV System utilises D.C. currents which do not disconnect under fault conditions.



Damage Statistics for photovoltaic systems - causes of damage

Lightning Protection

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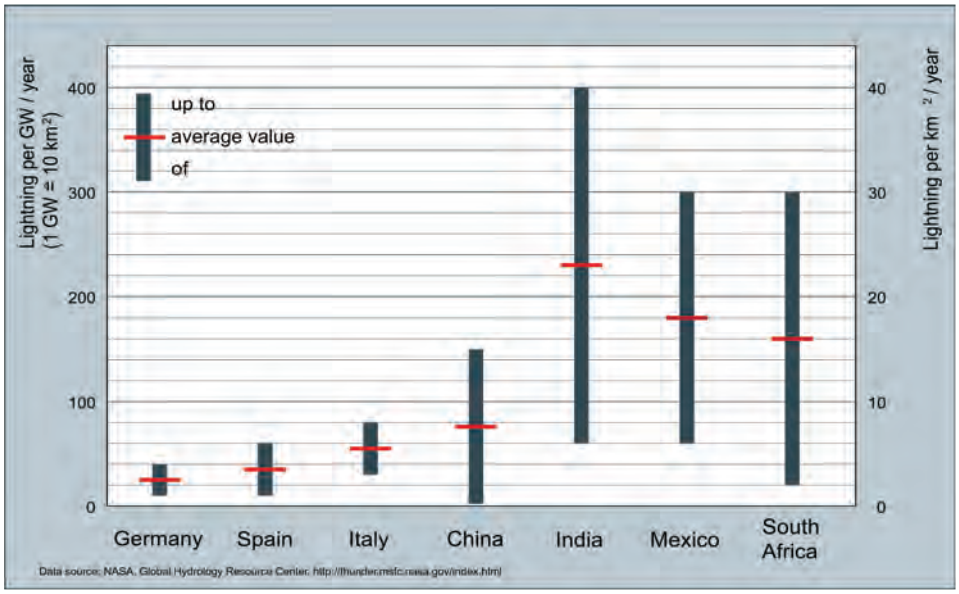


Lightning Flash Index in selected countires.

Damaged Solar Plant due to Lightning

The cost of repair, as well as the economic loss caused by downtime, must be taken into account. There are also various other factors such as the premature ageing of the PV components, and the risk of not meeting the PV plant's contractual requirements on the amount of power being generated not being achieved must also be considered.

The risk of damage caused by lightning must be determined in accordance with the SANS / IEC 62305 Part 2 Standard, whereby the results of the risk analysis must be considered at the design stage. In addition in *IEC 62305 Part 3 - Supplement 5 : 2014 - Lightning and Overvoltage Protection for Photovoltaic Power Supply Systems, a minimum lightning protection level III is specified for all PV systems > 10kW.*

Based upon the above it must be considered as 'Good Practice' to employ the proper earthing, lightning and surge protection systems. The installation of non-compliant / sub-standard lightning protection systems to save on the initial PV farm build costs will result in damage and downtime of the PV system and in the medium to long term be far more costly.

LIGHTNING PROTECTION MEASURES

To ensure effective protection, the lightning protection system must have the following optimally co-ordinated elements:

- Air termination and down conductor systems
- Earth termination systems
- Lightning equipotential bonding
- Surge protection system for power supply and data systems

The combination of the above elements form the complete lightning protection

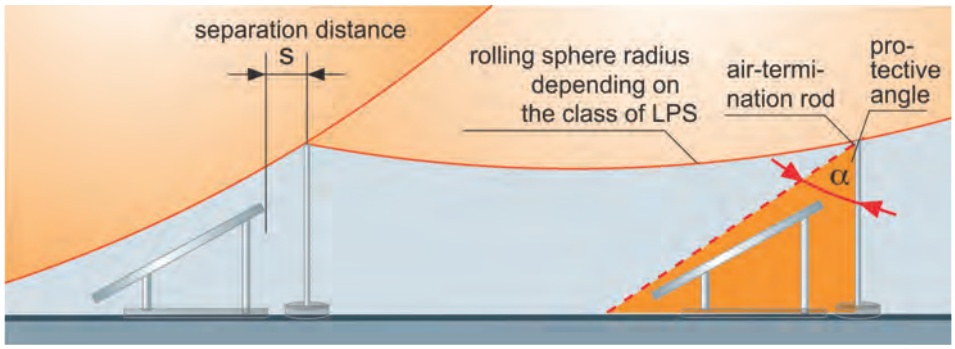
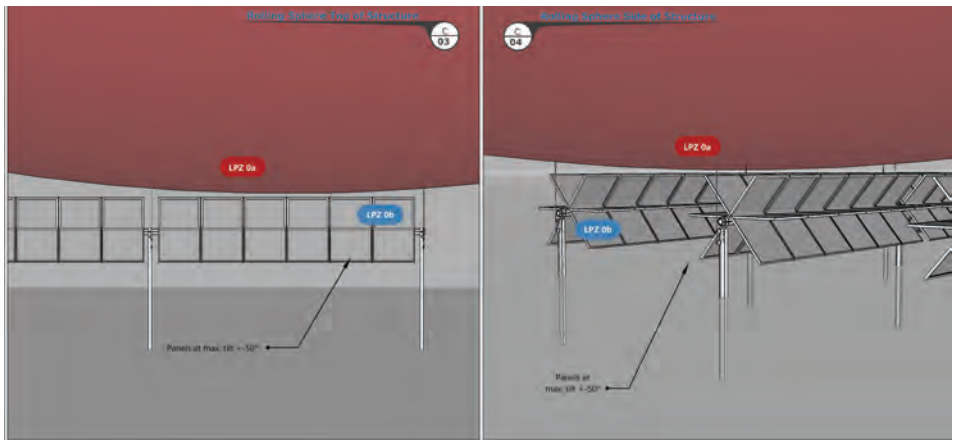


Fig 1: Rollng sphere vs Protective Angle of Air Terminals



The air termination system forms a critical part of the external lightning protection system. In the case of an uncontrolled lightning strike to the PV system, lightning currents will be induced into the electrical installation and cause severe damage to the system.

system, the parameters of each element is derived from the selected lightning protection level which is obtained from the lightning risk assessment process.

AIR TERMINATION AND DOWN CONDUCTOR SYSTEM

A properly designed air termination system will prevent lightning striking the electrical systems of the PV plant directly. All electrical systems including the PV panels must be located within the protection zone of the air termination system.

The air termination system should be designed in accordance with the parameters of SANS 62305 Part 3 and, as a minimum, the air termination design should be based upon a lightning protection level III system.

As shown in Fig. 1, generally the rolling sphere and angle of protection methods are employed for an air termination system that protects a PV array.

SHADOWING

When designing the air termination system, care should be taken that no solar panels are shaded by the air termination masts or rods. Diffused shadows caused by distant masts or rods, do not negatively affect the PV system or their yield.

Core shadows, however, cause stress to the PV cells and this leads to bypass diodes. The required distances from the air terminals must be calculated; for example the calculated minimum distance from a PV module of a 10mm diameter air terminal is 1.08m.

Umbra Effect

The region of the PV module which is completely obscured or shaded is called the Umbra and should be prevented in all cases.

The other region called the Penumbra or diffuse shadow, is when PV cells partly obscured when the air terminal or conductor only partly covers the sun.

Depending on the dimensions of the air terminal or conductor, the minimum distance required to prevent an umbra can be calculated.

EARTH TERMINATION SYSTEM

The earth termination system forms the basis for the effective surge protection and lightning protection of PV Power Plants. The design and installation of a properly formatted earth termination system is therefore a critical factor in providing effective protection solutions against lightning and induced surge currents.

In Annex D of Supplement 5 in IEC 62305 Part 3, a meshed earth termination grid ranging from 20m x 20m to 40m x 40m in size is specified. This type of grid earthing system has proven its effectiveness in practice. Supplement 5 also specifies that all metal PV module racks must be interconnected, the installation of the grid type earth termination system allows for this required bonding.

Lightning Protection

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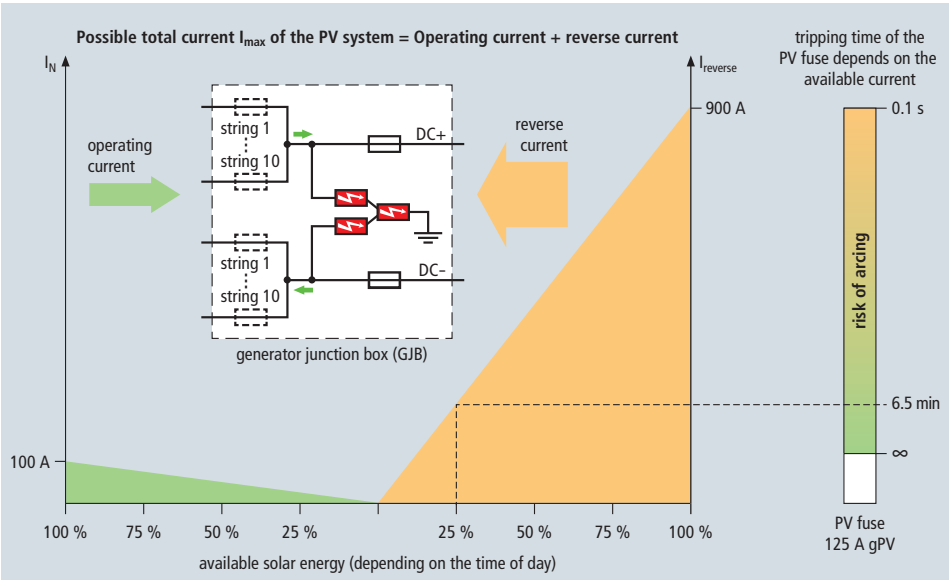

PV System with I_{max} of 1000A : Prospective Short-Circuit Current at the PV Arrester Depending on the Time of day

By intermeshing the earth termination systems, an equipotential surface is created across the site, which considerably reduces the voltage stress on the electrical connecting lines that run throughout the PV Plant and Operations Building. Large portions of the earth termination system are frequently installed in the cable trenches. If this is done then the routes must be closed to form grids.

The metal framework for the PV modules must connected to each other and to the earth termination grid. The metallic piles can also be used as natural earth electrodes, provided that they are made of a material and wall thickness in accordance with the minimum requirements of IEC / SANS 62305-3. Each PV array must be interconnected in such a way that it can carry lightning currents.

EQUIPOTENTIAL BONDING

Second to the installation of a grid type earth termination system, the correct equipotential bonding is of vital importance to providing effective protection to PV Plants. The installation of the proper grid type earth termination system provides the correct infrastructure for the effective equipotential bonding system.

Lightning equipotential bonding means directly connecting all metal systems in such a way that they are able to carry lightning currents. This includes all cabling and electronic systems. These electronic systems are equipotentially bonded into the LPS by means of lightning current arresters or surge arresters.

CABLE ROUTING

All cables must be routed in such a way that large conductor loops are avoided. This applies for single-pole series connections of the D.C. circuits (string) and for the interconnection of several strings. In addition, the data or sensor lines must not be routed across several strings to form large conductor loops with the string lines. For this reason, power (D.C. and A.C.), data and the equipotential bonding cables must be routed together as far as possible.

SURGE PROTECTION MEASURES

Surge protection devices (SPDs) must be installed to protect electronic systems in PV power plants. If lightning strikes the external LPS of a free field PV system, high voltage impulses are induced onto all electrical conductors and partial lightning currents will then flow into all copper cables (d.c., a.c. and data cables). The magnitude of the partial lightning current depends on various factors such as the type of earth termination system, the soil resistivity on the site and the type and size of the cables.

Supplement 5 of IEC 62305-3 requires a minimum discharge capacity of 10kA (10/350µs) for voltage-limiting Type 1 D.C. SPDs, this requirement takes into account the possible reverse currents that could occur. In PV systems with central inverters, fuses protect from reverse currents but these fuses only trip after some minutes.

When dealing with D.C. currents in PV plants, the maximum available current depends on the actual solar radiation. In order to reduce the risk of arcing, therefore, surge protection devices that are installed at the generator junction boxes must be able to handle the total current, consisting of both the operating and reverse currents and the SPDs must ensure automatic disconnection without arcing in the case of overload.

SPECIAL SURGE PROTECTION MEASURES FOR D.C. SIDE OF PV SYSTEMS

The typical curve characteristics of photovoltaic current sources differ

DEHN protects AFRICA

DEHN Africa provides lightning protection components for thatched roofs

DEHN Africa has recently introduced new methods of protecting thatched roofed structures in South Africa, and it is no longer necessary to have a ≥30 metre long mast installed. The latest preferred external protection system for installation on thatched buildings is the high-voltage-resistant insulated (HVI) lightning protection system that is compact, neat and approved by leading insurance companies and SANS.

For protection measures to be successful, air-termination conductors on thatched roofs must be installed as elevated traverses, for example: on isolating supports, with certain distances also to be kept for the eaves. Lightning Protection Systems should be designed to provide sufficient low impedance so that the lightning energy can follow in the required route. This requires an integrated design and effective use of material with enough low impedance

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Lightning Protection

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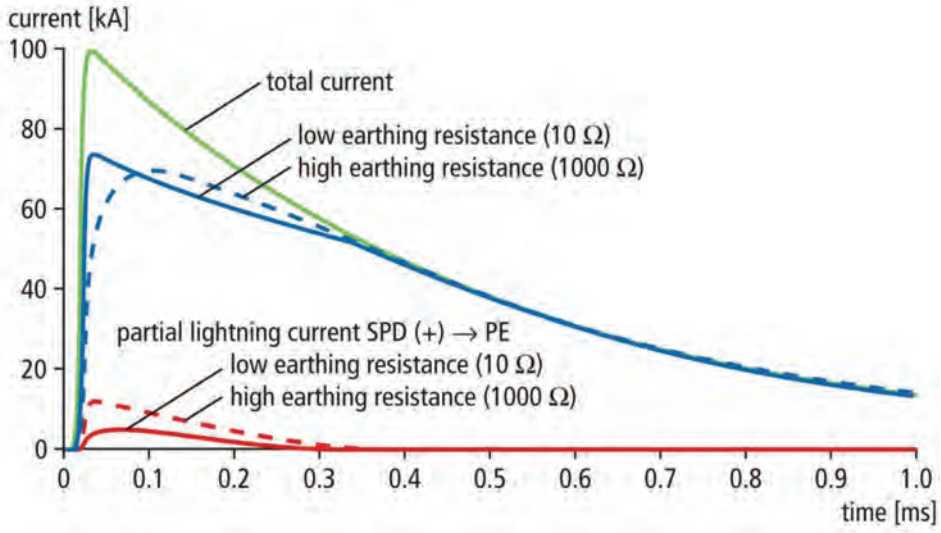


Lighting Current Distribution & Loading SPDs

substantially from conventional d.c. current sources. They have a non-linear characteristic and a different d.c. arc behaviour. These differences does not only affect the size of the D.C. switches and fuses but it requires surge protection devices that are capable of coping with these unique D.C. follow currents. Supplement 5 of IEC 62305-3 requires safe operation of surge protection devices on the D.C. side, even in the case of overload.

LIGHTING CURRENT DISTRIBUTION & LOADING OF SPDs

Lightning current is mostly dissipated into the ground via a properly design earth termination system (grid type) and only small partial lightning currents dissipate via the PV system`s cables, which are equipotentially bonded to the earth termination system via SPDs. This happens for both low resistance and high resistance earth termination systems.

It is therefore the shape and dimension of the earth termination that is important, not the earth termination resistance.

SIZE AND PLACEMENT OF SPDs

The most important factor in the selection of the type and placement of the surge protection measures, is the type of PV system:

Central Inverter (Fig 2)

A great portion of lightning current directly seeks a path to the earth via the DC cabling. The assumption that the whole surface of the PV system can be considered as "equipotential surface" is not realisable in practice.

The energy system cables work as an equipotential bonding conductors between the "local" earth termination at the module array where the direct lightning strike occurs and the "distant" equipotential surface of the central inverter.

Therefore, in PV ground-mounted systems with a central inverter, the partial lightning currents flow through the DC conductors between the generator junction boxes and the DC input of the central inverter.

Type 1 PV-SPDs need to be installed both at the DC-subdistribution boards and at the DC-input of the central inverter.

SIZE AND PLACEMENT OF SPDs

The most important factor in the selection of the type and placement of the surge protection measures, is the type of PV system:

String Inverter (Fig 3)

In case of string inverters, the power supply cables acts as equipotential bonding conductors between the "local" earth termination of the PV array and the "remote" equipotential surface of the infeed transformer.

Partial lightning currents flow on the A.C. lines, threfore the installation of Type 1 SPDs on the A.C. side of the string inverters and on the low-voltage side of the infeed transformer. Type 2 SPDs, which mainly limit induced interference impulses, are sufficient on the D.C. side of the string inverters.

PROTECTION OF DATA SYSTEMS

The ability to obtain reliable data from remote maintenance equipment via data cables is essential in the effective operation of the PV Plant. It is important to provide adequate surge protection to these data systems to prevent damage to the data system.

The string and inverter monitoring system, weather data acquisition unit, anti-theft protection and external communication system are based on different physical interfaces. Surge protection devices specifically suited to each type of interface must be selected.

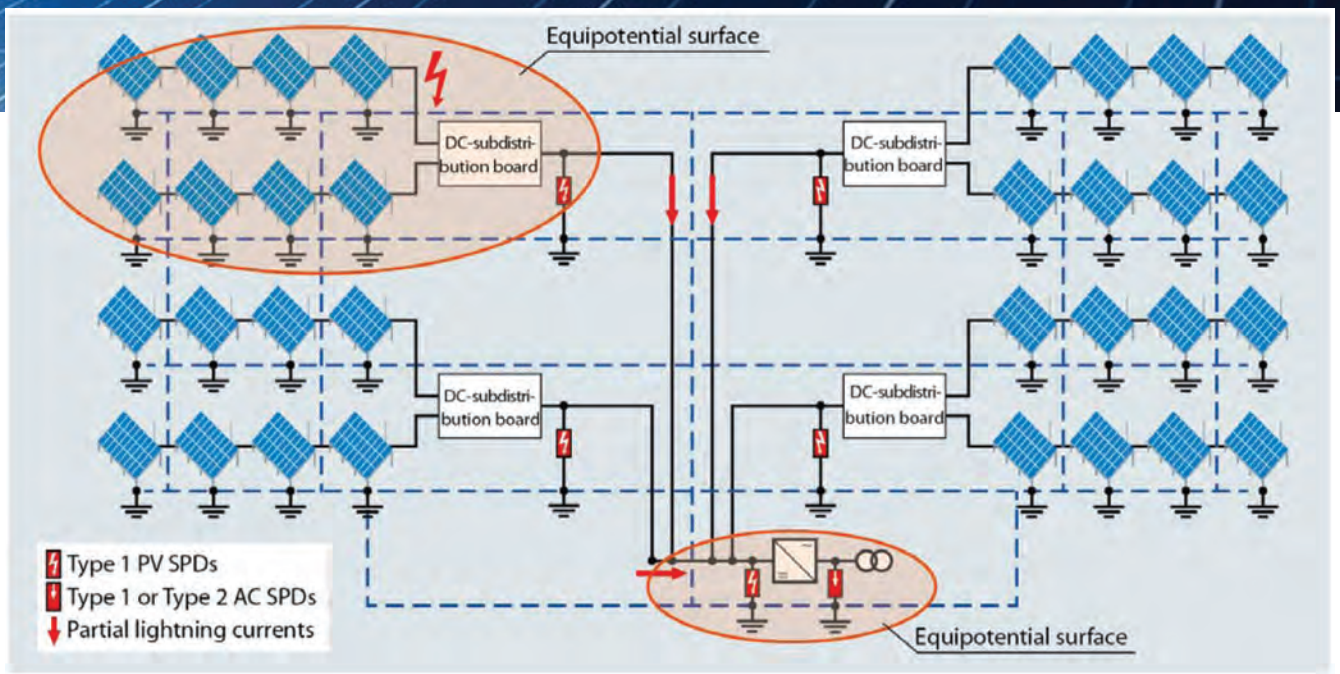


Fig 2: PV System with Central Inverter.

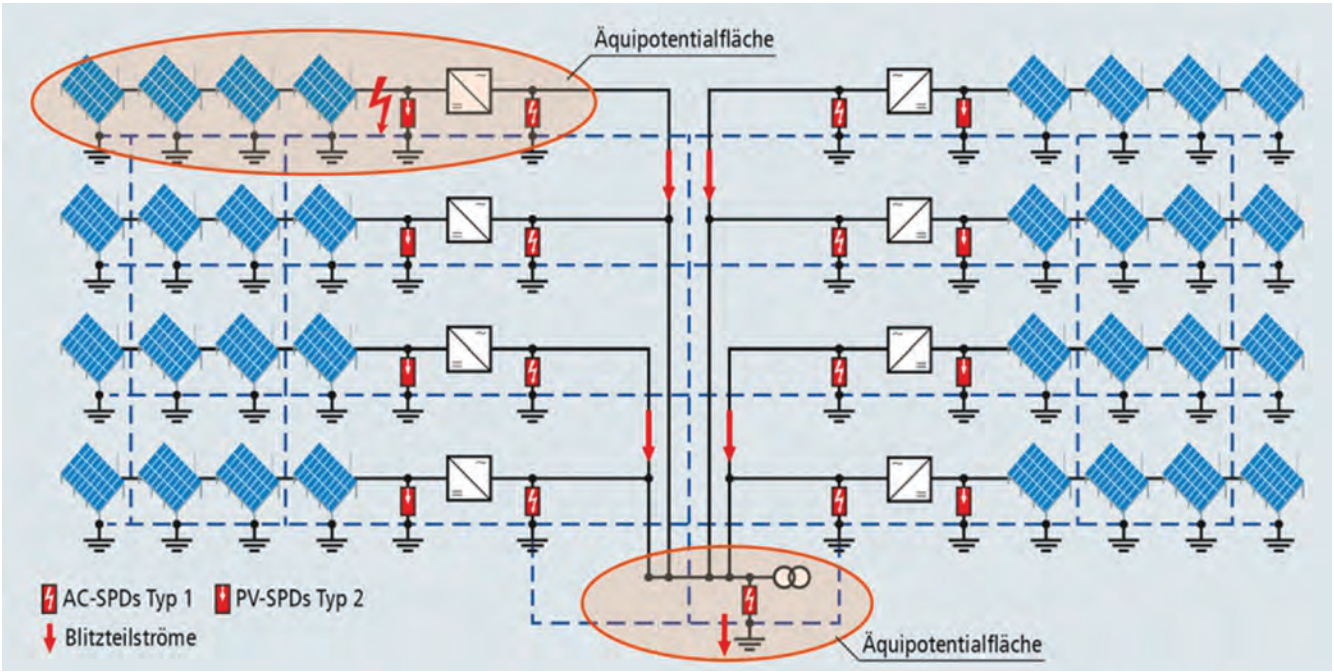
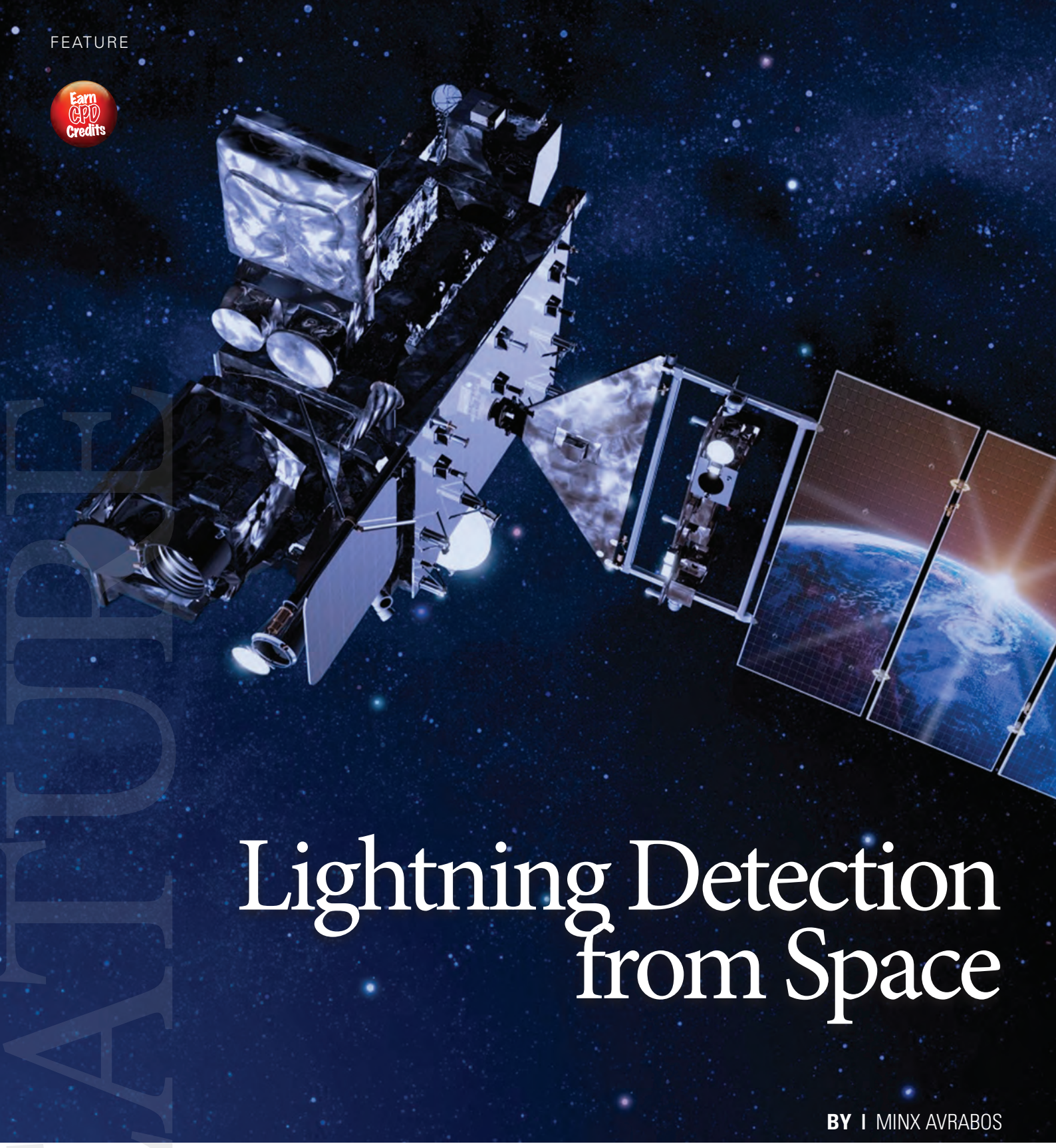


Fig 3: PV System with String Inverters.

CONCLUSION

In South Africa our high lightning flash indexes coupled with the large size and vulnerability of Free Field PV Power Plants makes the correct design and installation of the lightning and surge protection systems is imperative.

Proper lightning and surge protection for all systems gives enhanced performance of these power plants. The service and maintenance time as well as the repair and spare part costs are also reduced. wn



Lightning Detection from Space

BY | MINX AVRABOS

A new satellite instrument is giving forecasters their best views ever of these dangerous bolts.

The new images come from the Geostationary Lightning Mapper, an instrument onboard the GOES-16 satellite that can take a whopping 500 pictures a second, said engineer Tim Gasparrini of Lockheed Martin, which designed and built it.

The spectacular images helps meteorologists increase lead times for severe storm warnings. It's *"a quantum leap in forecasting severe weather such as tornadoes,"* Gasparrini said.

Geostationary Lightning Mapper (GLM)

Every second, dozens of bolts of lightning crack across the sky with flashes that can reach of 50,000˚C — five times as hot as the surface of the sun. Pinpointing exactly where and when lightning strikes the Earth holds a key for forecasting severe weather outbreaks.

The instrument is transmitting data never previously available to forecasters.

The mapper, the first lightning detector in a geostationary orbit, continually looks for lightning flashes in the Western Hemisphere.

It takes photos not only of the lightning bolts that hit Earth, but also the bolts that occur between or within clouds. These are actually more common and a precursor of cloud-to-ground strikes. It also detects the lightning activity at the tops of the clouds.

These flashes help forecasters know when a storm is intensifying and becoming more dangerous.

Rapid increases of lightning intensity signal that a storm is strengthening rapidly and could produce severe weather.

Lightning Detection from Space

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Scientists are able to spot a significant increase in total lightning activity, often many minutes before ground-based radar detects the potential for severe weather.

"We receive warnings sooner than if we only had radar," Goodman said. *"This adds information the forecaster can really use."*

When combined with radar and other satellite data, this data helps forecasters anticipate heavy rain and issue flood and flash flood warnings sooner. In dry areas, information from the instrument enables forecasters, and ultimately firefighters, identify areas prone to wildfires sparked by lightning.

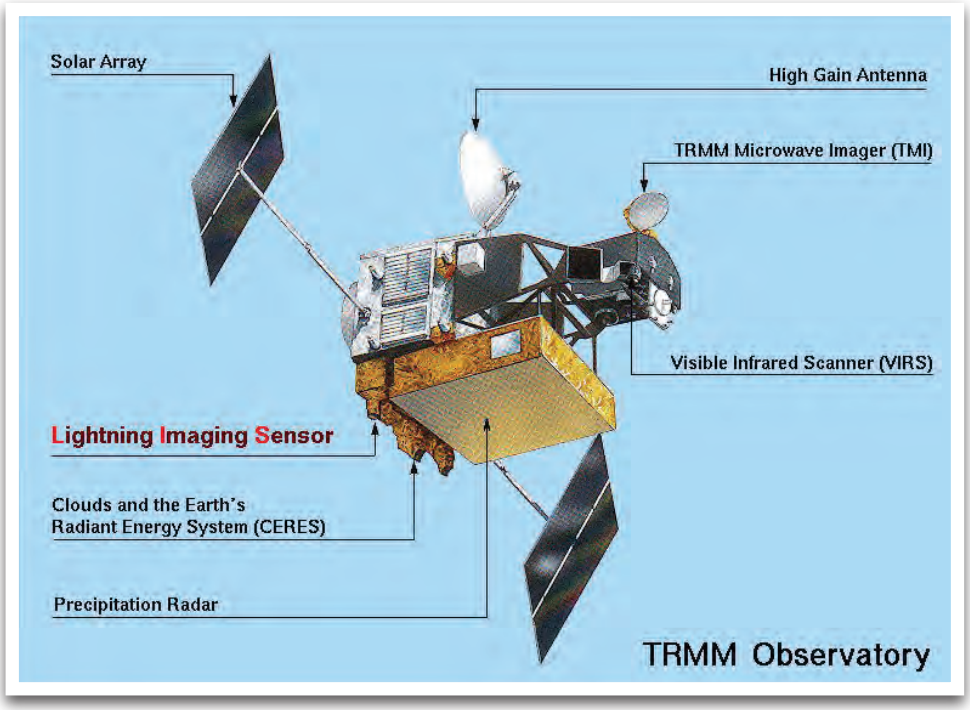
NOAA's (National Oceanic and Atmospheric Administration) GOES (Geostationary Operational Environmental Satellite) satellite, which orbits 35 000 kms above the Earth, was launched in November 2016.

The school bus-sized satellite, known as "GOES-R" when it was launched, and now by its new name "GOES-16," is in a "geosynchronous" orbit of the Earth. This means it hovers in the same spot above the planet, about 34,000 kms above the equator and it moves with the Earth as it rotates.

In addition to this lightning mapper, there are five other new instruments on board the satellite, which generate new or improved meteorological, solar and space weather data.

GEOSTATIONARY LIGHTNING MAPPER (GLM)

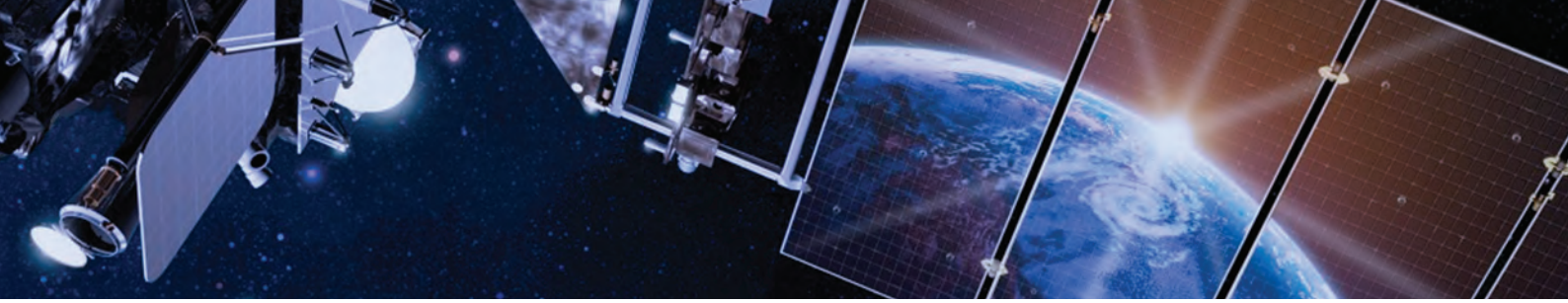
The Geostationary Lightning Mapper is a single-channel, near-infrared optical transient detector. This can detect the momentary changes in an optical scene, indicating the presence of lightning. The GLM measures total lightning (in-cloud, cloud-to-cloud and cloud-to-ground) activity continuously over the Americas and adjacent ocean regions, with near-uniform spatial resolution of approximately 10 km.

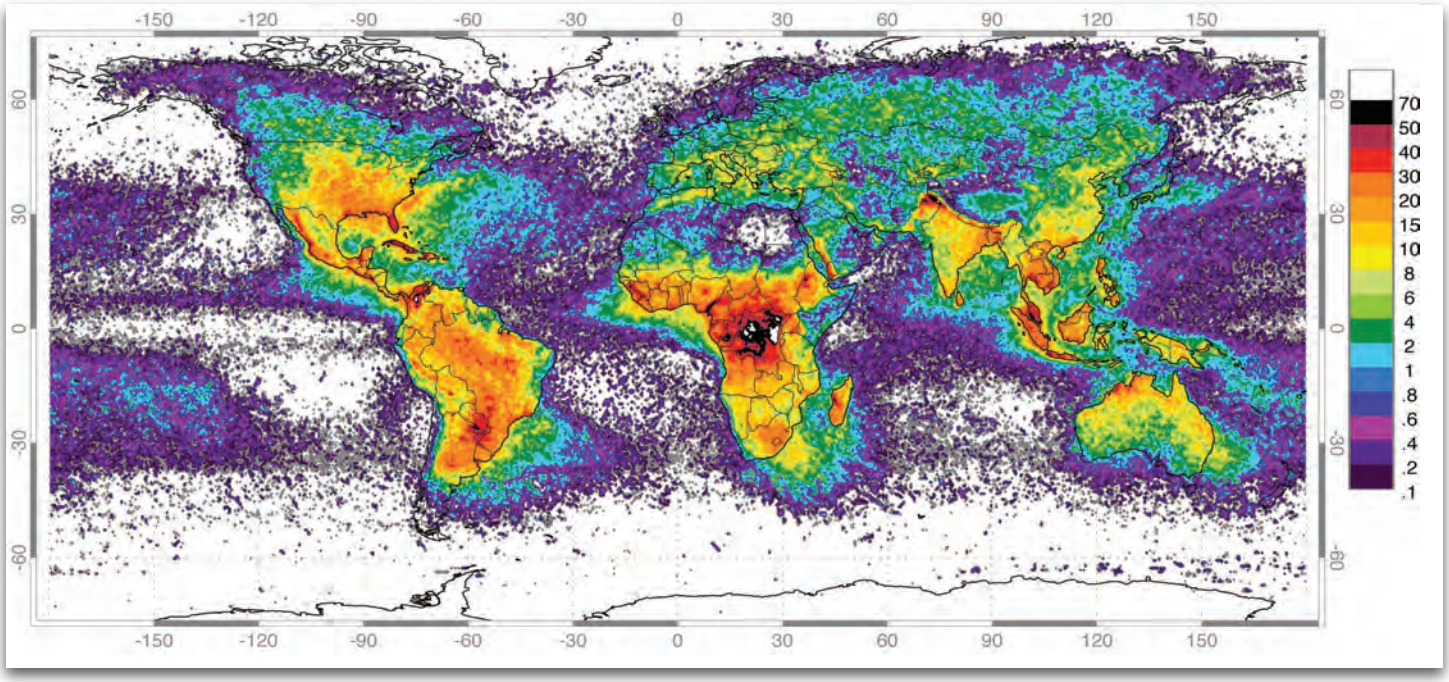


It is the first operational lightning mapper flown in geostationary orbit.

The GLM collects information, such as the frequency, location and extent of lightning discharges, to identify intensifying thunderstorms and tropical cyclones. Trends in total lightning is available with the GLM and provides critical information to forecasters. This allows them to focus on developing severe storms much earlier than previously. Severe storms exhibit a significant increase in total lightning activity, often many minutes before the ground-based radar detects the potential for severe weather. Used in combination with radar, satellite data, and surface

GLM Unit





Summary of global lightning detected with the LIS instrument

observations, total lightning data from GLM has increased lead time for severe thunderstorm and tornado warnings and reduce false alarm rates. Knowledge of total lightning activity and its extent helps to improve public safety. Data from the instrument is used to produce a long-term database to track decadal changes in lightning activity. This is important due to lightning's role in maintaining the Earth-atmosphere electrical balance.

GLM CHARACTERISTICS

- Staring CCD imager (1372 x 1300 pixels)
- Near uniform spatial resolution 8 km nadir*, 14 km edge fov**
- Coverage up to 52 deg N lat
- 0-90% flash detection day and night
- Single band 777.4 nm
- 2 ms frame rate
- 7.7 Mbps downlink data rate (for comparison- TRMM LIS 8 kbps)
- 20 sec product latency

GLM MEASUREMENTS

GLM measurements can provide vital information to help the operational weather, aviation, disaster preparedness, and fire communities in a number of areas:

- improvement in tornado and severe thunderstorm lead times and false alarm reduction;
- early warning of lightning ground strike hazards;
- advancements in the initialization of numerical weather prediction models through better identification of deep convection;
- improved routing of commercial, military, and private aircraft over oceanic regions where observations of thunderstorm intensity are scarce;
- improved ability to monitor intensification or decay of storms during radar outages, or where radar coverage is poor or scarce, such as in mountainous areas and oceanic regions;
- better detection and short range forecasts of heavy rainfall and flash flooding;
- ability to monitor the intensity change of tropical cyclones, which is often accompanied by increased lightning activity; and
- continuity and refinements of lightning climatology within the GOES field of view.

LIGHTNING IMAGING SENSOR (LIS)

The Lightning Imaging Sensor (LIS), is a space-based instrument used to detect the distribution and variability of total lightning (cloud-to-cloud, intra-cloud, and cloud-to-ground lightning). It measures the amount, rate, and radiant energy of lightning during both day and night. Two LIS instruments were built in the 1990s, one for the Tropical Rainfall Measurement Mission (TRMM) and a spare which was stored on a shelf for over 20 years. A

** the point on the celestial sphere directly below an observer | ** Field of view*

Lightning Detection from Space

continues from page 31

summary of the two platforms highlights the differences. The TRMM LIS operated successfully for over 17 years, from launch in 1997 until April 2015.

LIS SENSOR

The LIS instrument consists of a collection of instrumentation centred around a staring imager that is optimized to locate and detect lightning at millisecond timing with storm-scale resolution over a large region of the Earth's surface. Resolution of measurement and region of coverage varies depending on the orbit and altitude (whether on TRMM in a semi-equatorial orbit or on the ISS.)

The LIS is a calibrated lightning sensor which uses a wide field-of-view expanded optics lens, with a narrow-band filter (at 777 nm), in conjunction with a high speed Charge-Coupled Device (CCD) detection array. A Real Time Event Processor (RTEP) inside the electronics unit is used to determine when a lightning flash occurs, even in the presence of bright sunlit clouds. Weak lightning signals that occur during the day are hard to detect, witg other instrumention, because of background illumination. The RTEP removes the background signal, thus enabling the system to detect the weak lightning signal and achieve up to a 90% detection efficiency. The efficiency with which lightning detection occurs varies depending on time of day and the intensity of the lightning. The instrument records the time of occurrence of a lightning flash, measures the radiant energy, and determines the location of flashes within its field-of-view.

USE OF LIS DATA

LIS data is used to study mesoscale phenomena such as storm convection, dynamics, and microphysics. These are related to global rates and amounts, and distribution of convective precipitation, as well as to the release and transport of latent heat, which are all influenced by global scale processes. LIS data is vital to our understanding of global lightning and thunderstorm climatology.

ISS LIS

The spare LIS built for the TRMM program was carefully stored for future use. This LIS was placed on the International Space Station in February 2017. LIS was mounted in the station as part of the U.S. Department of Defense (DoD) Space Test Program (STP)-H5 science and technology development payload.

By placing the LIS on the space station,which has a highly inclined orbit, a greater geographic range of measurements are obtained than previously measured by TRMM LIS. The ISS LIS provdes total lightning measurements between +/- 48 degrees latitude a geographic range nearly all global lightning.

ISS LIS monitors total global lightning in both day and night, and will provide important cross-sensor calibration and validation, with the Geostationary Lightning Mapper, together with ground-based lightning networks. ISS LIS will also supply near real-time lightning data over data-sparse regions, such as oceans, to support operational weather forecasting and warning.

The TRMM Satellite travels a distance of 7 kilometers every second (nearly 16,000 miles/hour) as it orbits the Earth, which allows the LIS to observe a point on the Earth or a cloud for almost 90 seconds as it passed overhead. Despite the brief duration of the observation, it is sufficient to estimate the flashing rate of most storms. The instrument records the time of occurrence, measures the radiant energy, and determines the location of lightning events within its field-of-view. The TRMM LIS detection efficiency ranges from 69% near noon to 88% at night.

The TRMM satellite has a semi-equatorial orbit that is inclined 35 degrees with respect to the equator. The satellite altitude was 350 km from 1997 until 2001, at which time it was raised to 403 km. The orbit gradually declined in the last year of operation from 2014 - 2015. In 2015, TRMM was removed from orbit. The TRMM satellite orbit characteristics allowed for LIS observations in the tropical and subtropical regions of the globe between +/- 35 degrees latitude. Field-of-view and measurement spatial resolution varied slightly for each of the two orbital altitudes.

The LIS EOS Mission Objectives included Cloud Characterization, Hydrologic Cycle Studies, Storm Convection, Microphysics and Dynamics, and Seasonal and Interannual Variability of Thunderstorms. TRMM LIS contributed significantly to several of the TRMM mission objectives by providing a global lightning and thunderstorm climatology from which changes (even subtle temperature variations) were easily detected. wn

Cornelius Plath
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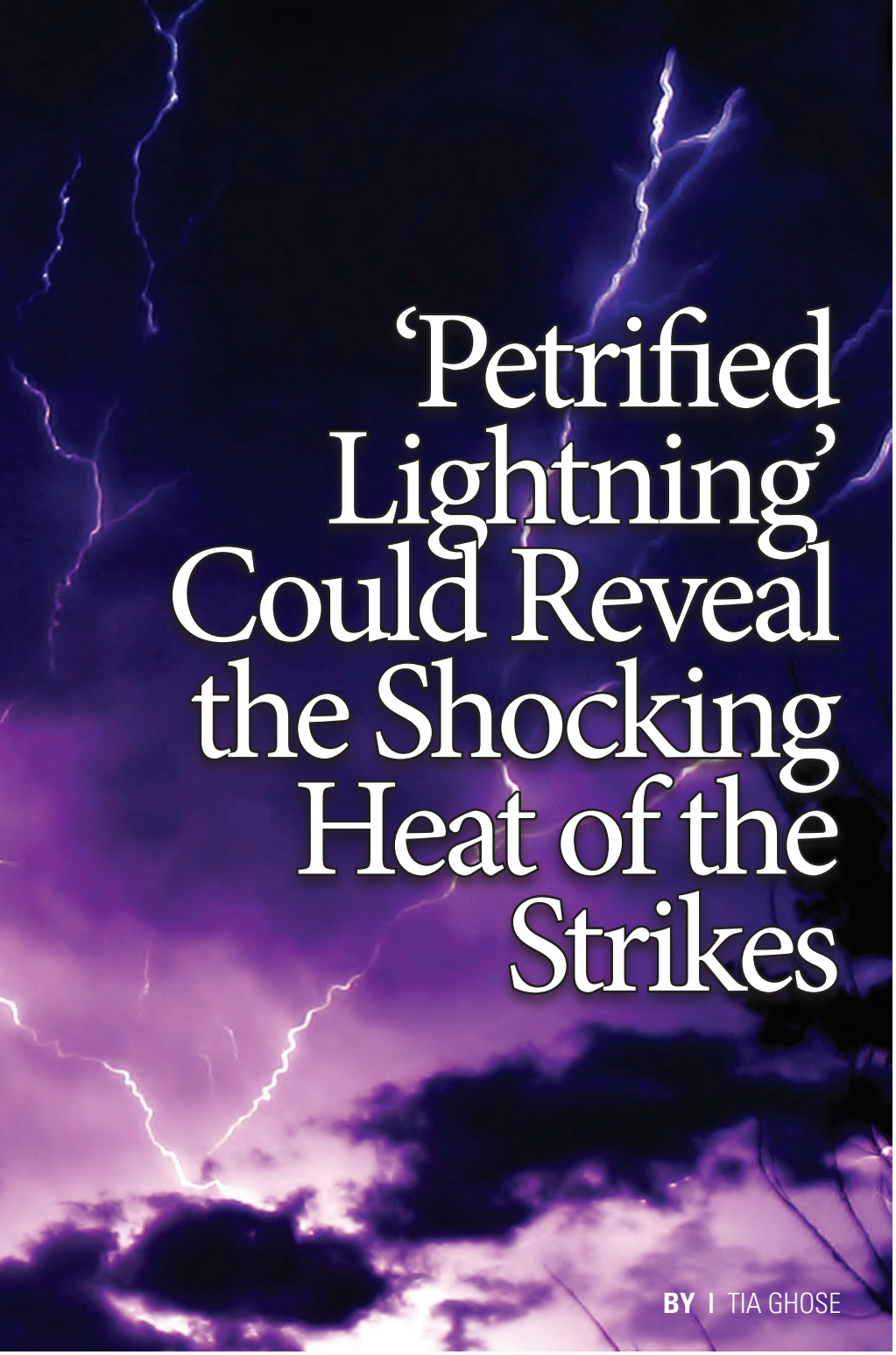
Zap!

Petrified lightning, or rocks that have been zapped and superheated by a lightning strike, could reveal details about the shocking weather phenomenon, new research suggests.

When lightning strikes a rock, the huge jolt of current heats up the material for microseconds, vaporizes substances inside and forms a glassy rock called fulgurite, study co-author Jiangzhi Chen, an applied physicist at the University of Pennsylvania, said at the annual meeting of the American Geophysical Union.

By analyzing the bubbles that form inside fulgurite, Chen and his colleagues can calculate hot the material gets, and that, in turn, can reveal insights into how exactly lightning works, Chen said.



'Petrified Lightning' Could Reveal the Shocking Heat of the Strikes

BY | TIA GHOSE

LIGHTNING CAN WARP ROCKS AT THEIR CORE

A zap of lightning can change the very structure of a rock, new research shows.

When a high-energy lightning strike bombards a rock, it can heat the rock to more than 1,600˚C. This can be twice as hot as lava, and not only deform the appearance of the rock, but the chemical bonds that hold it together.

When this happens, the lightning-zapped rock becomes covered in natural glasses called fulgurites. In the new study, the researchers took a microscopic look at the quartz fulgurites and found "shock lamellae" - a thin layer of warped quartz crystals - underneath the glassy quartz, induced by the high pressure of the strike. This warped layer consists of distinct, parallel and remarkably straight lines and can only be seen with intense magnification. These features control the fundamental structure of the rocks.

The only other known natural event to induce shock lamellae is a meteorite impact.

"I think the most exciting thing about this study is just to see what lightning can do," lead study author Reto Gieré, a professor of earth and environmental science at the University of Pennsylvania, said in a

Petrified Lightning

continues from page 35

statement. *"To see that lightning literally melts the surface of a rock and changes crystal structures, to me, is fascinating."*

GLOSSY ROCKS

The researchers found the shock lamellae in glassy fulgurites in Les Pradals, in southern France. The fulgurites looked like wet, dark algae and formed in the crevices of a jagged fracture that sliced through a granite rock outcrop there.

After looking at very thin, almost transparent, slices of the fulgurites under a powerful microscope, the researchers noticed that the black fulgurite looked glossy, *"almost like a ceramic glaze,"* Gieré said.

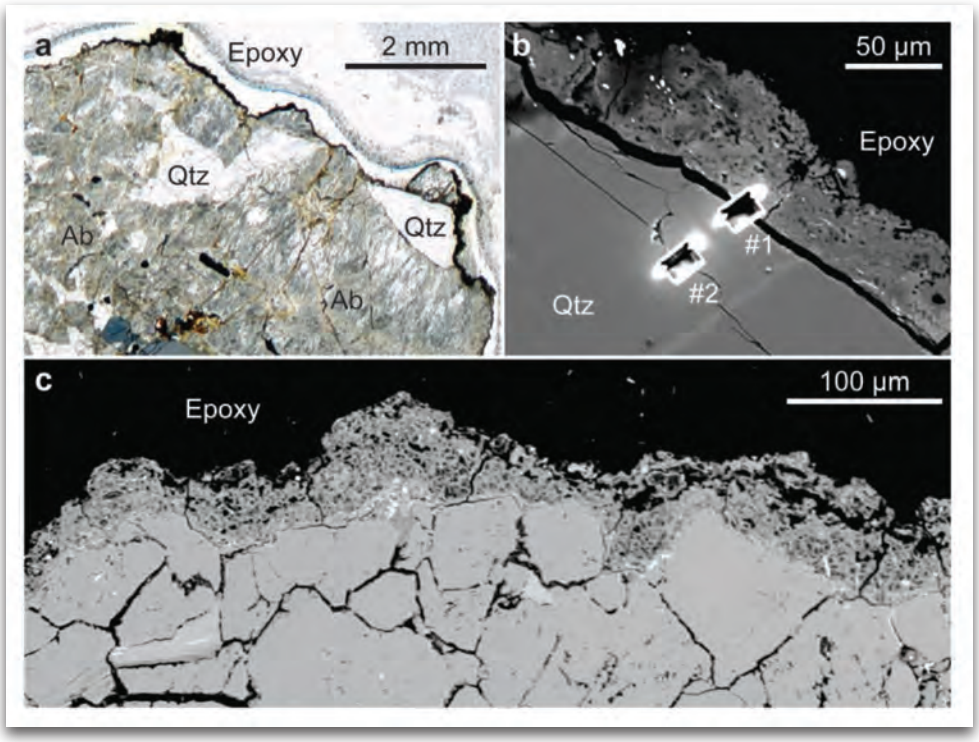
The fulgurite was also porous, similar to foam; the researchers suspect it got that way when the sizzling lighting vaporized the rock's surface.

The researchers detected elevated concentrations of sulfur dioxide and phosphorus pentoxide, likely left over from lichens that lived on the rock's surface in the time leading up to the lightning strike.

TRANSFORMED ROCKS

Just beneath the fulgurite layer, the researchers found the shock lamellaes. To create such a pattern, the lightning strike must have pummeled the rock with a force of around 10 gigapascals, which is equivalent to an impact 20 million times greater than a boxer's punch.

The researchers determined the force that formed the lamellae on the lightning-struck rocks by looking at lamellae formed by meteor impacts. Lamellae formed by both impacts shared similar features. *"It's like if someone pushes you, you rearrange your body to be comfortable,"* Gieré said. *"The mineral does the same thing."*



Lightning-induced shock lamellae in quartz

The extent of the lamellae — which typically spread about 3 micrometers wide, a small fraction of the width of a human hair — indicates how far the lightning bolt's energy was distributed.

The researchers warned outdoors people exploring or researching rock outcrops to be on the lookout for shiny black glaze, since it might indicate a site is prone to lightning strikes.

"Once it was pointed out to me, I started seeing it again and again," he said. *"I've had some close calls with thunderstorms in the field, where I've had to throw down my metal instruments and run,"* Gieré said.

Lightning occurs when an electrical current is transmitted from clouds to the ground, illuminating the sky and creating dangerously high voltage. But even though this is one of the more everyday occurrences in nature, scientists understand very little about how lightning actually works.

Researchers have a variety of methods of measuring the energy and current generated during a lightning strike, such as taking pictures of the actual strikes. But because lightning strikes are random, it can be hard to catch them in action. What's more, many of those methods can differ by several orders of magnitude, Chen said.

By contrast, fresh fulgurite can be easily acquired a day or two after a lightning strike. The rock is also easily distinguishable: It has reddish patches and burn marks from the lightning strike, Chen said. Fulgurite is also filled with bubbles that form when substances such as carbon dioxide, water and oxygen in the rock vaporize, Chen added.

Fulgurites - Products Of Lightning

To see if they could get understand the temperatures and energy levels reached when lightning strikes, Chen and his colleagues cut a piece of fulgurite rock from the top of Mount Mottarone in Italy. Chen then thinly sliced the rock, put it under a microscope, and characterized the size, distribution and number of vapor bubbles in the material.

Scientists can determine the underlying composition of the rock by measuring the frequencies of light that reflect off of it.

Knowing that, combined with a model of how frequently bubbles seed at different temperatures, Chen and his colleagues can come up with an estimation of just how hot the rock got during the lightning zap, and how long it stayed hot. That, in turn, can give some understanding of the lightning strike's total energy, he said.

Still, there are some limitations in this estimate.

When lightning strikes *"only a fraction of the energy is actually transmitted to the rock,"* Chen told Live Science. The rest gets dissipated as it electrifies the air and causes the thunder that accompanies the strikes, among other things, he said.

Right now, the findings are a matter of pure scientific curiosity, but they could potentially make it easier to study other huge shocks to the Earth, such as bomb blasts and meteorite strikes.

"Those impact events are relatively to difficult to study, but lightning hitting a target is relatively easy to find," Chen said.

HOW HOT IS LIGHTNING?

Lightning is one of the most destructive forces in nature. But for all the folklore and legends amassed over human history on lightning, we know surprisingly little about the inner workings of this powerful phenomenon, including something as simple as how the current that flows through a thunder-inducing flash is related to the temperature of the strike.

"The basic physics of lightning, such as lightning initiation and lightning propagation, is not fully understood at this point," said Robert Moore, a lightning researcher from University of Florida in Gainesville.

"We know the basics, but not the details. So when anybody makes headway, it is major news."

Lightning causes more than $5 billion in damages every year in the U.S., as well as more fatalities than hurricanes.

"A direct hit from a lightning strike can melt a power cable or start a forest fire, where the amount of heat from the lightning plays a major role," said Xiangchao Li, a scientist from China who specializes in lightning research. Li and his team discovered a mathematical relationship between the current intensity and the temperature inside lightning. Their result was published last month in the journal Scientific Reports.

Although there are approximately 100,000 lightning strikes on Earth every single day, the randomness of the occurrences makes it difficult for scientists to study them in an effective or systematic way. So until Thor, the Norse god of lightning as well as other meteorological events, joins a lightning research team, scientists are left to their own devices.

Luckily such a device does exist. Known as an impulse current generator system, the device can create artificial lightning with currents up to tens of thousands of amperes. For perspective, a household or automotive fuse is usually rated well below a hundred amperes, and an electric current of just a few amperes can easily kill you. A natural lightning strike typically carries around 20-30,000 amperes of current. Certainly there are other factors such as size and setting of natural lightning that cannot be replicated in a laboratory, but just in terms of sheer current output, the lightning generated by the device can really give Thor a run for his money.

By using their artificial lightning system, Li and his team were able to dial up lightning strikes at will, with currents between 5,000 to 50,000 amperes. This resulted in artificial lightning strikes with temperatures as high as 9,500˚C, twice as hot as the surface of the

Petrified Lightning

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Sun. This creates a new problem — at such high temperatures, a normal thermometer would explode. And even if it didn't, it wouldn't react quickly enough to register the temperature of the lightning strike.

Fortunately, there is "light" in "lightning." Li and his team were able to record the lightning's temperature within a millisecond by measuring the intensity of the light at various wavelengths.

After striking lightning at the same place over and over again, they concluded that the relationship between the current and temperature of lightning is a highly logarithmic one, meaning that the temperature difference between lightning strikes with 1,000 and 10,000 amperes is similar to those with 10,000 and 100,000 amperes. This result provides solid evidence for previous theoretical predictions that lacked the support of data.

"The next step would be to compare with measurements from rocket triggered lightning, or natural lightning, which can be done throughout the U.S. or China," Moore suggested.

That's right, rocket-triggered lightning. Essentially a glorified version of Benjamin Franklin's wired kite, scientists today have ways to siphon natural lightning from the sky by launching an electrically grounded rocket, as shown in the video below.

With a better understanding of the physics of lightning, scientists can help engineers to improve current protocols and infrastructures to better deal with lightning -- from weather warning systems to the design of power grids.

FACTS AND FIGURES ABOUT LIGHTNING

The important facts of lightning are:

- It must be respected at all times, not just during the peak periods of a thunderstorm.
- It is the result of high voltage currents.
- It is unpredictable. This makes researching natural organic strikes very hard.
- Most characteristics of lightning are intelligent estimates of typical values formed from other data.
- A properly installed lightning protection system will help to protect a property or structure from lightning damage. The Empire State Building is proof of this.
- There is estimated to be around 2,000 lightning storm active around the global at one time creating over 100 strikes per second. These thunderstorms generate a potential difference of 200,000 to 500,000 volts between the Earth's surface and the ionosphere, with a fair weather current of about 2×10^{-12} amperes/metre^2.
- Data from NASA's space-based optical sensors reveal the uneven distribution of worldwide lightning strikes.
- Approximately 300,000 lightning strikes hit the ground in Britain each year with 30 percent of reported lightning strikes causing severe damage. Each year 30 to 60 people are recorded as being struck by lightning, 3 of whom, on average, die (14 in 1984 compared to 2 in 2005). In the USA around a 100 residents are killed by lightning every year. These figures are dropping with time as working practices change; and as we become more aware of the dangers of lightning and how to protect ourselves to reduce its risks. Using a lightning protection system is a good way to protect buildings and structures from the damaging effects of a lightning strike. As global warming makes lightning storms more prevalent the necessity to have lightning protection will rise.
- The majority of lightning occurs in the storm cloud itself and only 10 to 20 percent of all lightning reaches the ground.
- Even though a lightning strike (lightning flash or stroke) appears continuous, it is really a series of short bursts following the paths of ionised air called stepped leaders. Typically they are about 30 metres in length, however they can be anything from 10 to 100 metres in length. The initial lightning strike can also be followed by secondary strokes utilising the same ionised air channel. Up to 4 secondary strokes can be expected, though much higher counts have been recorded. Each lightning stroke typically lasts only last 10 to 50 microseconds (0.000050 sec) and carries hundreds to thousands of amps.
- The air around a lightning strike is typically superheated to about 20,000˚C (over 3 times hotter than the surface of the sun (estimated at 5,500˚C)). The air temperature can range from 8,000 to 30,000˚C. The rumbling sound of thunder is caused by shock waves from multiple stepped leaders that make up a lightning stroke. As the air in each leader is superheated by the immense current it rapidly expands creating a supersonic shock wave. Differently timed shock waves are created from the different stepped leaders at varying attitudes in quick succession along the path of the

lightning. This causes the thunder clap from each stepped leader to arrive at your ears at differing times generating the rumbling effect.

- The estimated peak power per lightning stroke is 10^{12} watts (1,000,000,000,000 watts or 1,000 Giga Watts). The total energy in a large thunderstorm is thought to be enough to power the whole of the USA for 20 minutes.
- A tall thunderstorm cloud can hold over a 100 million volts of potential. The voltage potential in a lightning bolt is proportional to its length, and varies depending on the diameter of the bolt, air density and impurities of the air (humidity, dust, ash). The electrical breakdown of air (ionisation) normally take 3,000,000 volts per metre; however with the ambient electric fields of a charged thunder cloud and impurities in the air, ionisation normally takes place at much lower voltages during a storm. Lab tests have shown a leader will advance if the tip of the streamer is about 4.5 kV (4500 V) for a negative charge and 5.5 kV (5500 V) for a positive charge.
- An average lightning strike discharges about 30,000 amperes (20,000 amperes in the UK). The current in a lightning strike typically ranges from 5,000 to 50,000 amperes depending on the strength of storm. NASA has recorded strikes of 100,000 amperes and there are other reports of strikes over 200,000 amperes.
- The resistivity of clear, fair-weather air ranges from around 4 x 10^{13} ohm meters at sea level, to around 1.3 x 10^{16} at 12km elevation. Typically air is considered an electrical insulator. However with impurities (eg. water, dust ash) its resistance is lowered and therefore varies further. Unlike metals whose resistance increases with temperature, when the temperature of air increased, it has similar characteristics to semiconductors, in that its resistance lowers. So when air is ionised into a plasma state, and then superheated to 25,000˚C, it conducts electricity very well.
- Lightning can and does strike the same place twice. On average lightning strikes the Empire State Building in New York City (USA) about 100 times every year. 49 strikes have been recorded in a single day.
- A leader of charge, called a positive streamer, can reach upwards from the ground 15 to 50 metres in an attempt to join stepped leaders from a storm cloud. This normally happens just before a lightning strike.
- Benjamin Franklin in 1752, is believed to be the first to show that lightning was electricity, using his now famous kite experiment. He is certainly the inventor of lightning rods and used them in creating lightning protection for important buildings. Following a series of experiments at his own home, lightning rods were installed to the Academy of Philadelphia and the Pennsylvania State House in 1752 giving both these buildings lightning protection.
- May 10 1752, Thomas-François Dalibard of France successfully conducted Franklin's first experiment before Franklin did by using a 12 metre tall iron rod instead of a kite, and he extracted electrical sparks from a cloud.
- June 15 1752, Franklin is said to have conducted his famous kite experiment in Philadelphia and also successfully extracted sparks from a cloud, though this was not written up until 1767, some 15 years later by Joseph Priestley.
- In the northern hemisphere lightning occurs more during the summer months. However, in equatorial regions, lightning appears more often during the fall and spring.
- Arctic and Antarctic have very few thunderstorms and, therefore, almost no lightning at all.
- The open oceans do not experience as many thunderstorms and lightning strikes as land does. This is due to water's higher heat capacity preventing the heating of low-lying air which is crucial for thunderstorm formation.
- Most cloud-to-ground lightning strikes are generally the transfer of a negative charge from the cloud to earth. These are identified by the downward pointing branches of lightning and are called negative flashes. Ground to cloud lightning is far less frequent, however they can occur where leaders propagate from tall earth bound objects toward the storm cloud. These are identified by upward pointing branches of lightning and are called positive flashes.
- Lightning does not travel straight down to earth, due to impurities in the air like dust, causing it to break down more easily in one direction than the other. The shape of the electric field generated by the charge in the cloud also has an effect. Lightning may not always strike the top of the tallest object in an area. It is possible for lightning to strike very close to the base of a tall object.
- When lightning strikes the ground, radial currents spread out from the site of the strike, causing damage to anything nearby.

Petrified Lightning

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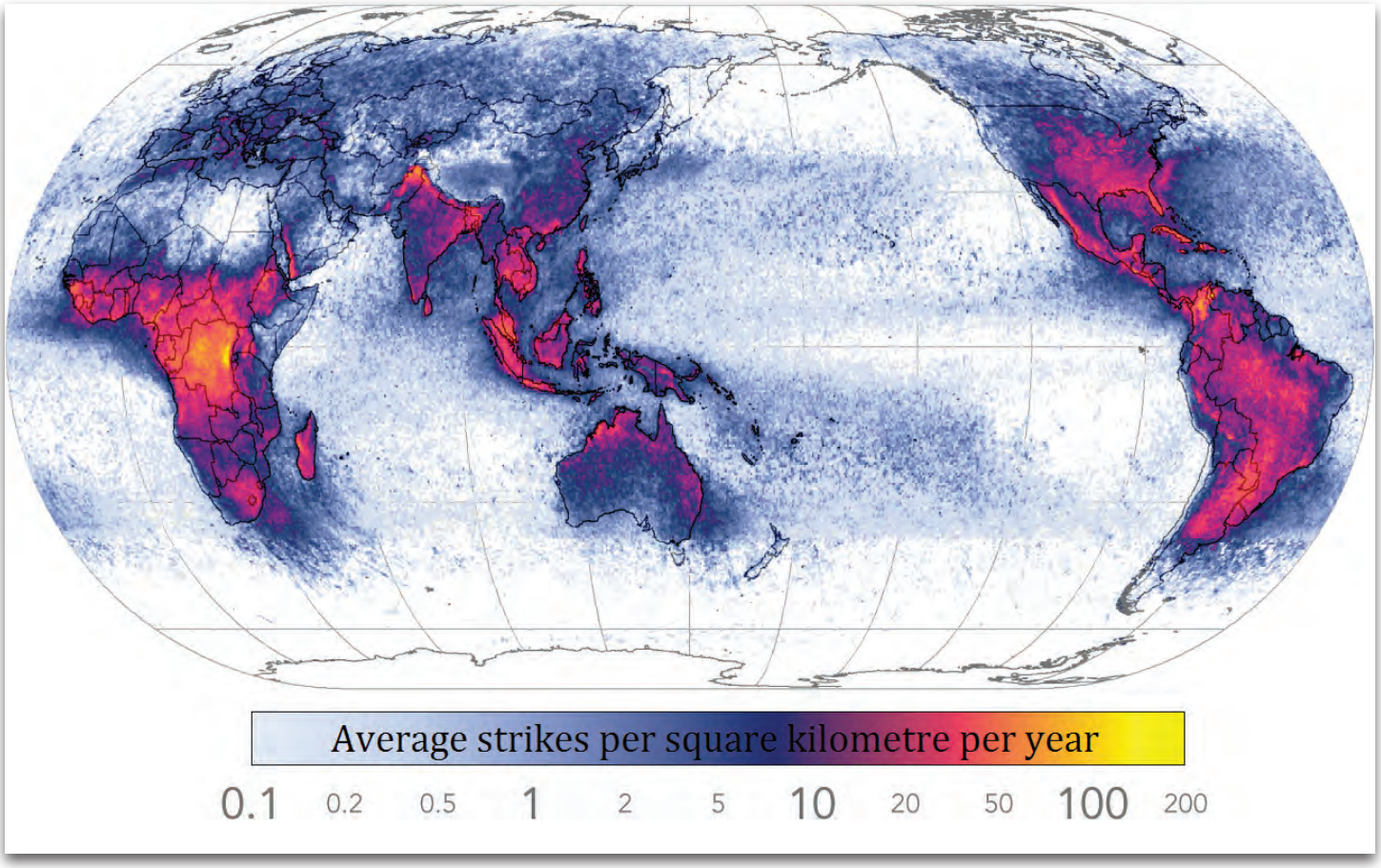

World map showing frequency of lightning strikes, in flashes per square kilometer (km²) per year (equal-area projection). Lightning strikes most frequently in the Democratic Republic of the Congo.

- Storm clouds, called cumulonimbus clouds, can tower 20-25 kms high (Mount Everest is 9 kms high.). They form at altitudes of 150 to 4,000 metres and typically have peaks 6,100 m, though in extremes cases they can be as high as 24,000 m.
- Lightning does strike twice in the same place. A number of secondary lightning strikes (possibly 30 to 40) can quickly follow the ionized path of the first strike, giving the impression of the lightning lasting longer.
- Research shows that proximity to water (eg. pool, lake or sea) increases the risk of being struck by lightning.
- Stepped leaders are normally 2 to 5 cm in diameter, however they can be over a metre.
- The frequency and strength of thunderstorms varies for different geographical locations. The average current passed in a lightning strike is 20,000 amperes, in Florida (USA) the average is over 45,000 amperes per lightning strike. Researchers believe this is due to the hot and wet conditions in Florida (USA) being ideal for creating tall and highly charged storm cloud formations.
- Positive lightning from the top of storm clouds is normally over 6 times stronger than negative lightning due to the longer distances it typically has overcome. Sometimes referred to as "bolts from the blue" they can occur when there is very little cloud activity compared to the thunderstorms associated with negative lightning. The unexpectedness and the greater strength make positive lightning the most dangerous type of lightning. Positive lightning makes up less than 5% of all lightning strikes.
- Lightning strikes most frequently in the Democratic Republic of the Congo. wn

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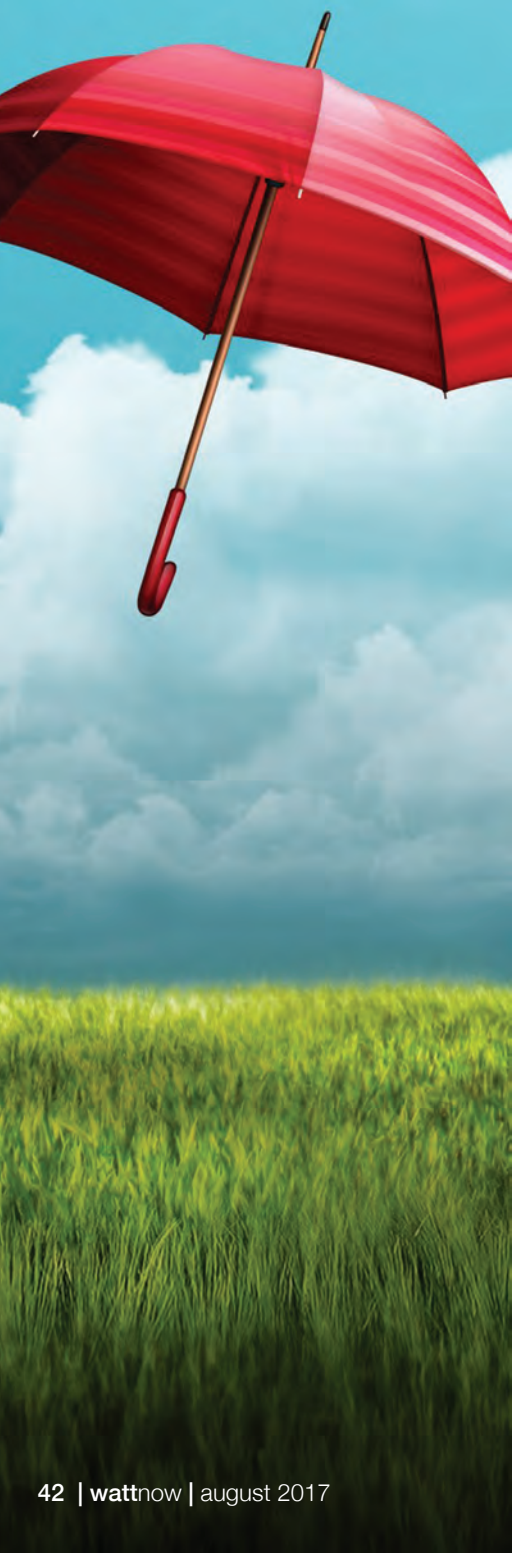

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The International Electrotechnical Commission (IEC) is a natural part of any engineer's life, first introduced to one at the beginning of their training (a University for many), it becomes impossible to untangle one's work from it.

BY | DARRYN R. CORNISH | WINNER 2017 IEC YP ESSAY COMPETITION

The necessity of the IEC in my work

DARRYN R. CORNISH
WINNER 2017 IEC YP
ESSAY COMPETITION

No matter what aspect of work an engineer is involved with, standards are closely linked. I currently work at SASOL, and whilst SASOL has its own standards, they are, like almost all others in South Africa, derived from the IEC standards. In general, standards exist for two basic purposes: standardising equipment and techniques to allow for a common framework within industries, and ensuring equipment and techniques are conducted correctly and safely. The IEC, as an international standards organisation, serves this purpose at a relatively high level, allowing for the accurate communication worldwide, as well as work and equipment to be traded across the world with very few difficulties in compatibility.

As I am an electrical engineer at SASOL, and a part-time PhD student at Wits University (with a long background at Wits including lecturing), these two viewpoints are balanced in different ways in the two major portions of my life: application and research. I have experience with both the application of the IEC standards at my electrical engineering position at SASOL, and the research viewpoint as a postgraduate researcher at Wits University for almost 5 years. Whilst both viewpoints are looking at the same standards, there are subtle differences between these viewpoints.

SASOL is a large company with varied interests and plants bigger than the adjacent towns that surround them. As expected of such a large company, dedicated to the production of various products, the clear majority of employees are technical in nature, from artisans and technicians to the engineers and managers. Given the size of their plants, the number of technical employees at any plant can quite easily dwarf some towns. The plants of SASOL are quite dangerous, and the only thing keeping most of the technical personnel safe are the standards around their work. As SASOL is a chemical production company, with many of these chemicals flammable and unstable, all technical personnel must adopt safety standards, not only for their safety, but that of their colleagues. This is the core tenet around standards at SASOL: safety of yourself and those around you. Unfortunately, accidents are impossible to prevent entirely, and there are quite frequently notices of people being hurt, either through human error, not following the standards or, in rare cases, unavoidable coincidence.

I stress the safety aspects quite heavily, as they are a vital necessity at SASOL and other similar companies in the various industries. However, standards do have other purposes. Many standards exist to describe how to overcome issues that others have encountered in the past. Many of these issues may be unseen, and standards help to highlight the various problems that can occur. Thus, different aspects must be considered when designing or implementing a new system, or even upgrading current systems. Standards serve as a log of the previous work that professionals have done, and their various difficulties.

The necessity of the IEC in my work encountered (as well as the way to overcome or even pre-empt these difficulties) provides practical insights. Whilst these insights are critical, they are not the only way in which standards are used throughout the world.

The neccesity of IEC in my work

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Research at Wits University, especially in the High Voltage environment, has a distinct viewpoint. Research is often dependent upon standards to a degree that, as a basic tenet of engineering is "Don't reinvent the wheel". This essentially says that, if previous work has proven a certain point, it is unnecessary to re-test that point. A researcher is however a sceptic at heart, and whilst we rely on the standards to help with research, we often must critically evaluate the standards as well.

Many a research project has been completed on extending a standard, or attempting to improve it to match experimental results more closely. This means a researcher must not only question a standard very closely, but have a deep understanding of the standard as well. This is necessary: to understand exactly where and when the applicability of the standard ends, the base assumptions made by the standard, and where the standard is not necessarily a good guide. A good example of this is the IEC 60060-1 standard used for the Up-Down U50 test to determine the impulse withstand voltage of a device. The standard is quite complete and thorough, but many will fall into a common mistake.

In the standard, the change in voltage for each step (ΔV) is used as a constant value, which is difficult to achieve for the Marx generator in Wits' high voltage lab. Instead, one needs to analyse the output data, using fundamental probability to ensure the correct outcome.

The standard does explain the basis behind the equations it uses, but many a student has fallen into the trap of using the equations, forgetting this basis (ΔV is constant), resulting in incorrect values. This is also an example of the theoretical being merged with the practical application of that theory, a place in which standards tend to shine.

Wits is also fortunate enough to be involved in quite a bit of high voltage testing, as it is one of the few places that can test high voltage equipment, owing to its high voltage lab. This results in quite a bit of consulting work, for example, testing the impulse withstand voltage of sample line insulators to validate datasheets, or check for suspected defects and so on. This can become quite extreme, such as testing a bushing at close to 1 MV impulse voltage, which requires the clearing of the lab due to the safety clearances required. This also brings many of the aspects of engineering into one place. The idea of separated topics within engineering is an old, but increasingly incorrect one.

An example of this is how high frequency engineering is viewed completely separately from that of high voltage, but a knowledge of the high frequency field is still critical. Impulse voltage testing is a good example, since an impulse has a huge frequency bandwidth, which requires special construction of the voltage divider, and a matching component for the measurement connection, to accurately measure the impulse. Again, where the theory meets application, and the practical aspects of what was learned as a student, becomes clear that a standard often epitomizes.

Around all of this, I have been an active participant in the IEEE and SAIEE since I was a student. That gave me a view into the profession before I was fully involved as a professional myself. This perspective also showed me that, only through the volunteer work of technical professions can the current techniques and equipment in the field be fully understood.

The necessity of the IEC in my work is safely utilised and managed. The volunteer aspect of engineering is often overlooked, and many do not grasp the impact these volunteers have had on their lives on a day to day basis.

An engineer can easily lose sight of two aspects when it comes to standards: how prolific and entwined with the profession they are; and how much work goes into creating a standard. I was fortunate enough to be involved with several Cigré working groups, heavily in the case of D1.61, that gave an insight into the process needed to start the process of updating an existing or creating a new standard.

This work at Cigré will only eventually reach the IEC but it is quite fascinating to the see the process (and the amount of the work that goes into developing just a Cigré brochure). As previously mentioned, standards are not perfect and require constant updating, as our knowledge is expanded and improved by researchers every day. This is quite an exciting component of the IEC of which many are unaware: the necessity of updating and improving current standards to ensure safety and, in the case of research, more accurate results that can be compared worldwide.

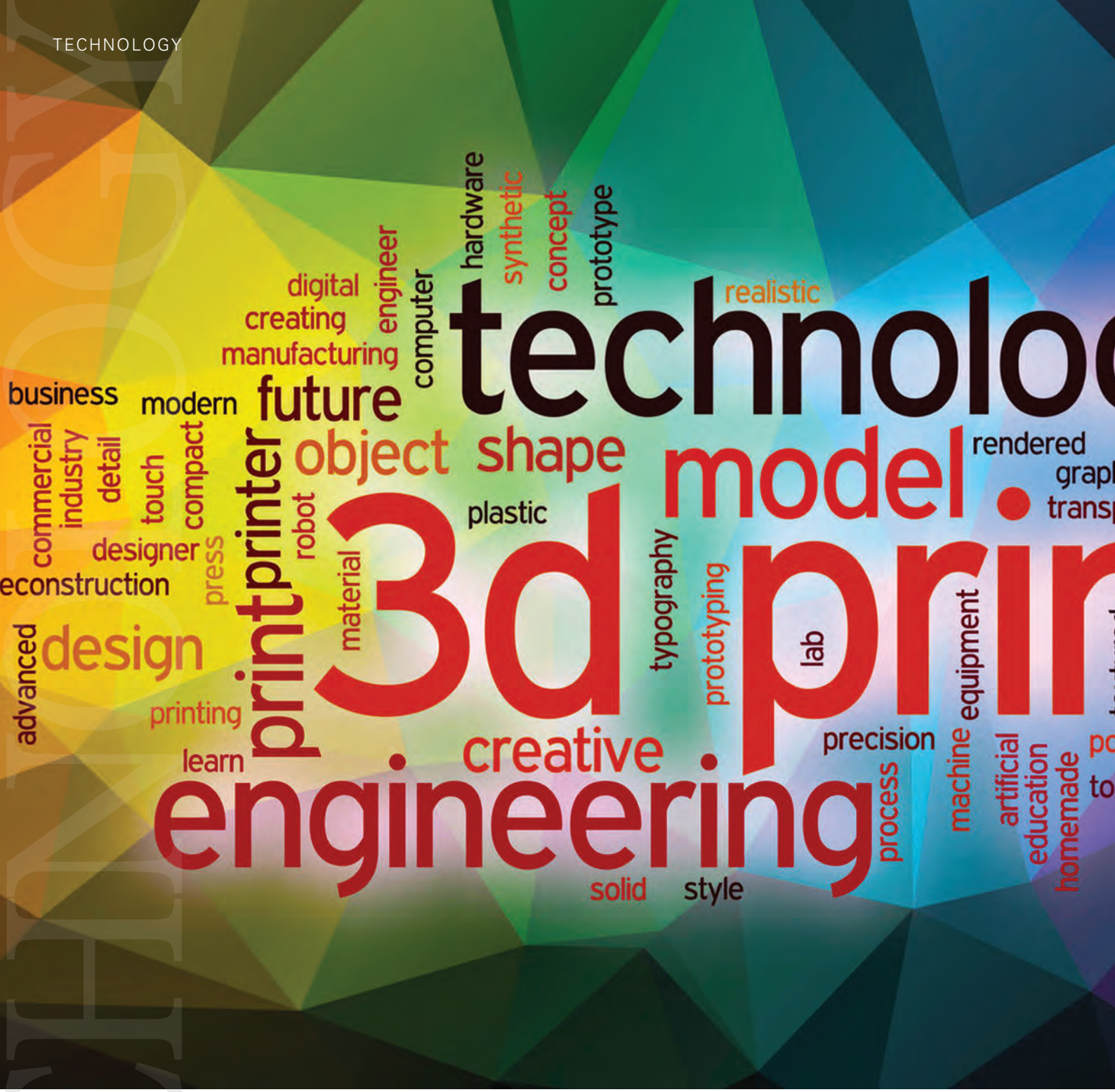
IEC standards are also very useful, as they often contain the reasoning behind the methods and choices made in the standard. Some standards often just lay out the ground work, with little to no explanation why the various components of the standard where crafted in the way they were. IEC

standards on the other hand, from my experience, not only describe the technique or equipment, but explain why the various choices and requirements were made for the standard. This is critical, especially in research, as often the reasoning may make the technique or equipment unsuitable for what is required in the research.

A good example of this necessity, from my previous research, are the voltage breakdown ratings for air gaps at DC, and impulse ratings. There is large amount of research going into the DC voltage breakdown ratings, as the current standards have been found to be slightly inaccurate at some of the extremes of the factors, such as encountered in Johannesburg, South Africa. This work is being conducted in various countries, with Cigré actively investigating and attempting to develop a working model, as HVDC becomes more and more common around the world for power transmission networks. This is ignoring the relatively new branch of hybrid HV AC/DC power transmission lines, that have very little working data on which to develop new standards. The link between Universities, companies, and the standards organisations becomes clear in cases such as those illustrating how the entire system is dependent upon each of these components, as well as how they are inter-dependent in many ways.

Clearly, the IEC is entwined with almost every aspect of my work in an inescapable fashion. From that alone, putting energy into the IEC is not only a good idea, but a necessity for my own safety and the quality of my future work.

This can be construed as a selfish reason, but these benefits also extend to my fellow engineers and technical colleagues around the world. I hope that in the future, through organisations such as the IEEE, Cigré and the IEC, I can make some small contribution. WN



This comes as a combination of three well established technologies:

- Inkjet computer printers which first appeared in the 1970s. This is also similar to drum and flatbed pen plotters which work in vector mode rather than raster.
- CAD-CAM (Computer aided design - computer aided manufacturing) which has come into widespread use from origins in the 1960s.
- Sintering of granular or powdered material.

A brief summary of printing history:

WOODBLOCK PRINTING - 200 AD

Used for printing on textiles and paper, originating in China. Cylindrical seal rolls for making impressions on soft clay go back to Mesopotamia of 3000 BC.

MOVEABLE TYPE - 1040 AD

The first Chinese moveable type was of ceramic material. Thousands of books in the ancient Chinese script were published every year.

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3D printing is a new technology which is rapidly growing in maturity and sophistication and is set to revolutionise the manufacturing industry.

Woodblock printing 200AD

The ancient Chinese name stamp (chop) remains in use. In 1450 Gutenberg (c1400-1468) introduced the movable type printing press to Europe, using type made from an alloy of lead, tin and antimony. Gutenberg is famous for the first printing of the Bible in 1455. William Caxton (1422-1491) was an English merchant, diplomat, writer and printer. He is thought to be the first Englishman to introduce a printing press into England (1476) and was the first English retailer of printed books. Wynkyn de Worde (1455-1534) worked with Caxton, and was the first to popularise the products of the printing press.

3D Printing

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Movable type probably reached the pinnacle of its development in the 20th century, with the introduction of the molten metal Linotype machines used for typesetting newspapers.

An entire line would be cast as a single metal slug, after which the type would be free for further use. Papier mâché moulds (flongs) would be made of the page layouts (formes) - text, images and all, which would then be used for hot metal casting of the curved stereotypes for producing the print rolls. Rubber stereos remain in use for a variety of applications, including printing on cardboard boxes etc.

Etching

ETCHING - C.1515

In this process, a strong acid is used to etch unprotected parts of a metal printing plate. This technique has been used for producing many famous artworks and remains in use. Engraving is another method of preparing printing plates. Many famous works of art have also been produced by this method. The early printing of music was done by engraving copper printer plates.

MEZZOTINT - 1642

This was the first tonal method, enabling half-tones to be produced without the use of line or dot-based techniques. The tonality is achieved by roughening the surface of the plate using a tool with small teeth. The aquatint process also allows for large areas of tonality using rosin powder to control partial etching of the plate.

LITHOGRAPHY - 1796

The lithographic process relies on the immiscibility of oil and water. Images were originally drawn on smooth limestone plates treated with oil, fat or wax. The untreated parts were etched with acid, giving a surface that could retain water and repel the oil-based ink.

In 1837 chromolithography came into use using multiple plates for printing several colours. In modern lithography the image is made using a polymer coating applied to a flexible plastic or metal plate. The image can then be printed directly on paper from the plate or, in drum form, transferred to an offset roll (rubber blanket roll). The plate drum is continuously watered and inked. This has become the most common technology for printing since the 1960s. Web (continuous roll) printing is widely used for high quality, large production runs, printing in full colour on both sides of the paper. The rolls are capable of printing more than a million copies. Modern colour printing requires four translucent inks for subtractive colour – CMYK (cyan, magenta,yellow and black). Subtractive colours cannot produce white, which is provided by the paper or other stock. Photolithography is widely used for printing, including high quality full colour photographic images. It has also played a vital role in the mass production of integrated circuits in the microelectronics industry.

LASER PRINTING - 1969

Xerox was founded as The Haloid Photographic Company in 1906, originally manufacturing photographic paper and equipment. The document copying machine using a light scanner, dry powder toner and rotating electrostatic drum emerged after many years of development. The term Xerography was derived from the Greek meaning 'dry writing'.

Haloid became Xerox Corporation in 1961. Xerox researcher Gary Starkweather invented the laser printer in 1969 by modifying a Xerox copier. Laser printing received a huge boost when IBM introduced laser printers in 1977, after which they became ubiquitous worldwide. Modern desktop computer laser printers often combine the functions of printer, copier, scanner and fax. Laser printing and copying has superseded many forms of document copying such as: spirit copiers, typed wax sheet copiers, reflex contact photo copiers, blueprint copying, ammonia drawing copying etc. Silk screen printing remains

in use for printing on fabrics, bottles and other objects.

INKJET PRINTING - 1951

Possibly the earliest inkjet printer was patented by Lord Kelvin in 1867.

This gave a continuous trace on paper to record telegraph signals, using an inkjet nozzle deflected by an electromagnet. Commercial chart recorders were introduced by Siemens in 1951. Inkjet computer printers emerged in the late 1970s, and have become the most commonly used computer printers for desktop, as well as commercial use. The deposition of droplets has evolved into a highly developed, but challenging technology. For colour printing CMYK (Cyan, Magenta, Yellow and Black) cartridges are used which can produce photographic quality prints. Branching away from document production, printers can also use non-toxic ink for printing on edible paper for use in cake decoration. 'Ink' comprising living cells can be used for creating biosensors and tissue engineering.

CAD-CAM emerged in the 1970s, and became a revolutionary trend in manufacturing.

CAD uses a computer to design an object to be manufactured and also prepares data for a NC (numerically controlled) manufacturing machine.

CAM is the process of autonomously manufacturing the designed object. The machine can be highly sophisticated with multiple cutting tools available and multiple axis operations. These will include milling, drilling, thread cutting etc. Intricate designs can be handled in this way, which would be prohibitively expensive and time consuming using conventional methods. CAM is subtractive machining, removing material from the workpiece.

Sintering is the process of consolidating fine material into larger solid form, by heating and compression, but without liquefaction. Sintering of granulated or powdered material has been in use for more than a century.

Extensive use of sintering has been made in conjunction with blast furnaces. These were charged with huge quantities of iron ore, coke and limestone. The blast furnaces could not be charged with 'fines' (granular or powdered material) which would be sintered on a hot conveyor belt into lumps which could be accepted by the furnace.

Sintering is widely used in the production of filter elements. These can be made into a wide range of porosities, and from a variety of materials, to suit severe industrial applications.

3D Printing is initially similar to CAD, using computer software to design the workpiece and prepare a data file for driving the printer. 3D printing is additive manufacturing producing products by aggregating raw material. 3D scanning is widely used for preparing the data file. The printer will, in some respects, operate as an inkjet printer, but using a wide variety of materials instead of ink. The horizontal movements are made by the nozzle, and the vertical movement by slightly lowering the work platform for each layer. The printer will build the workpiece by printing a huge number of successive layers. For the dry processes, the work will be performed inside a box, which is levelled with powder with each successive print layer. The powder supports parts of the workpiece which are not yet attached to other parts. Extremely complex shapes using a variety of materials can be manufactured in this way. High strength metallic workpieces will require laser sintering to fuse the particles together.

There are several processes used in 3D printing.

Material Jetting

MATERIAL JETTING

(Field Deposition Modelling – FDM)

This is possibly the simplest 3D print process. The material is applied, layer by layer, in droplets through a small diameter nozzle, and the rest of the area filled with support material. The layer is then hardened by UV light. A levelling blade is passed over each layer of the workpiece. On completion, the support material is removed, much like the sand mould being removed from a metal casting.

BINDER JETTING

This uses layers of base material in the build chamber and a liquid binder is applied through a nozzle to form the correct

3D Printing

continues from page 51

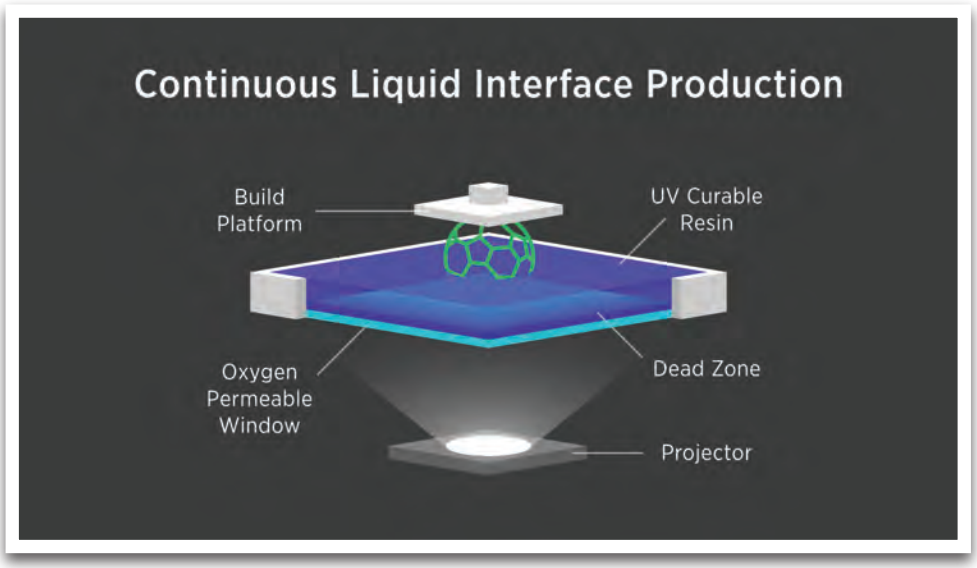
pattern for each layer. The unused material is then available for re-use.

VAT PHOTO-POLYMERISATION

This method of 3D printing uses a vat filled with photopolymer resin which is hardened by UV light. The vat will contain a working platform which can move vertically, layer by layer. The three processes are:

1. Stereo-lithography (SLA). This uses a vat of photopolymer which is cured by UV laser, layer by layer, joining each layer to the one below. A resin filled blade re-coats each layer with fresh material. Temporary supports must also be built to restrain detached parts of the object from floating out of position. Layers are typically 50 to 150 microns thick.
2. Digital Light Processing (DLP) uses traditional light sources such as arc lamps, which can cure photosensitive polymers. Entire layers of the object to be built are projected onto the surface of the resin, making this quicker than other forms of 3D printing.
3. Continuous Liquid Interface Production (CLIP) is a new ultrafast, method which is 25-100 times faster than conventional 3D printing. This process harnesses light and oxygen to continuously grow objects from a pool of resin, instead of printing them layer by layer. This produces products with consistent layerless mechanical properties, and enables a broad choice of polymeric materials. At the heart of the CLIP process is a special window that is transparent to light, and permeable to oxygen.

   By controlling the oxygen flux through the window, CLIP creates a "dead zone" in the resin pool, just tens of microns thick where photo-polymerization cannot occur. As a series of cross-sectional images of a 3D model is played like a movie into the resin pool from underneath, the physical object emerges. Seeing a complex shaped object emerge from the surface of a liquid is probably the most spectacular form of 3D printing.



CLIP Technology

MATERIAL EXTRUSION

Fused Deposition Modelling (FDM). This uses a plastic filament or metal wire from a coil, which passes melted through a heated nozzle which is able to control the material flow. The nozzle can move horizontally and vertically under the control of NC data from CAD software.

The material hardens immediately as it is extruded to form the workpiece layers. Two commonly used plastic filaments used are: ABS (Acrylonitrile Butadiene Styrene) and PLA (Polylactic acid). Support structures must also be built if required. The term 'fused deposition modelling' and its abbreviation to FDM are trademarked by Stratasys Inc. FDM is also known as FFF (Fused Filament Fabrication).

SELECTIVE LASER SINTERING (SLS)

This is also known as Powder Bed Fusion. SLS uses a high power laser to fuse small particles of plastic, metal, ceramic or glass powders into a mass that has the desired three dimensional shape. The laser selectively sinters the powdered material by scanning the cross-sections (or layers), generated by the 3D modelling program, on the surface of a powder bed.

After each cross-section is scanned, the powder bed is lowered by a thickness of one layer. A new layer of material is then applied on top, and the process is repeated until the object is completed. Unused material provides a support structure which can be later re-used.

Functionality of 3D printer manufacturing is hugely enhanced by 3D scanning, which reduces, or even eliminates the effort of producing the CAM data file. It is only a matter of time before cellphones appear with an app to do 3D scans, which then can directly drive a 3D printer. It will then be possible to 3D scan one's own feet

to produce a bespoke pair of shoes with a perfect fit, even if the wearers feet are not of exactly the same size or shape. Several shoe companies, including Nike, Feetz and UnitedNude are now using 3D print technology to provide customers with bespoke shoes – on the spot in the store.

The cost of 3D printers for home use has dropped dramatically – a desk top 3D printer to complement the home computer can currently be bought for less than R5,500.

The applications for 3D printer manufacturing seem endless. On 4 August 2017 Andreas Deuschle, Head of Marketing & Operations in Customer Services & Parts at Mercedes-Benz trucks, declared: *"With the introduction of 3D metal printing technology, Mercedes-Benz Trucks is reasserting its pioneering role among the global commercial vehicle manufacturers. We ensure the same functionality, reliability, durability, and cost-effectiveness with 3D metal parts as we do with conventionally produced parts."*

An obvious application for 3D printing is in the manufacture of medical and dental prostheses. Using 3D scanning and printing is highly cost effective in producing the complex and irregular shapes required. For bone and joint implants high strength titanium implants can be produced.

An Israeli company has applied to the US Patent and Trademark Office for legal rights to a process for making a special kind of human cell. The company, Nano Dimension, says it uses a specialized 3D printer to create an environment in which stem cells could grow into tissue. Stem cells can develop into many different kinds of cells in the body. They can also repair damaged tissues and organs. One kind, called induced pluripotent stem cells (IPS), are used to replace tissue lost to disease or injury. While 3D printers are used already to create stem cells for research, Nano Dimension said the trial, conducted with Israeli biotech firm Accellta Ltd, showed its adapted printer could make large volumes of high resolution cells quickly. 3D bioprinting enabled by the two companies' technologies, means that Nano Dimension and Accellta have the potential to accelerate high fidelity and high viability manufacturing of living cellular products. Accellta's technology can deliver large quantities of high quality cells which can be an enabler for printing even large and complex tissues and organs.

3D printed ear

Scientists in Australia have created brain-like tissue in the lab using a 3D printer and special bio-ink made from stem cells. The research takes us a step closer to making replacement brain tissue derived from a patient's own skin or blood cells to help treat conditions such as brain injury, Parkinson's disease, epilepsy and schizophrenia. The bio-ink is made of human induced pluripotent stem cells (iPSC), which have the same power as embryonic stem cells to turn into any cell in the body, and possibly form replacement body tissue and even whole organs.

A 3D printer was installed aboard the International Space Station in 2014. The printer works by extruding heated plastic, which then builds layer upon layer to create three-dimensional objects. Testing this on the station is the first step toward creating a working "machine shop" in space. This capability may decrease cost and risk on the station, which will be critical when space explorers venture far from Earth and will create an on-demand supply chain for needed tools and parts. Long-term missions would benefit greatly from onboard manufacturing capabilities.

3D Printing

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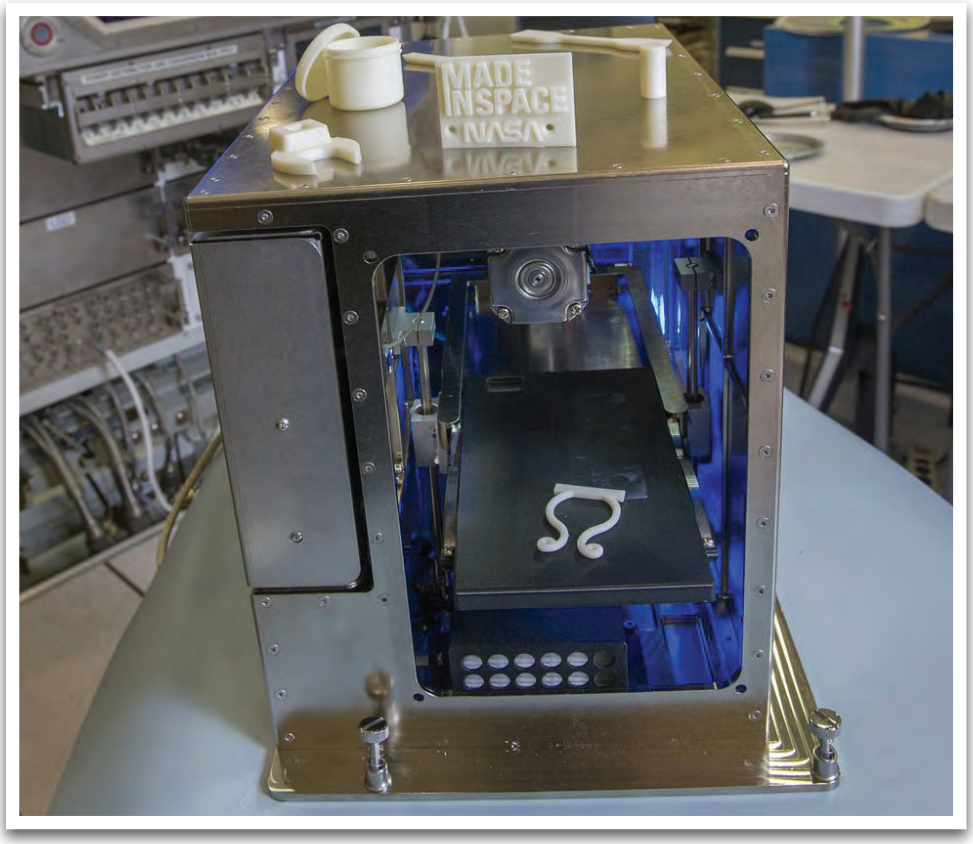

3D printer which was installed abord the International Space Station.

is readily attainable however a layer thickness of 10 microns can be achieved by some processes. If a choice is to be made between FDM and SLA it will be found that FDM has greater ease of use while SLA can achieve resolution unobtainable from FDM. SLA will require more post-printing clean-up.

3D scanning and printing has reached a high level of precision and sophistication. We can expect to see further developments bring greater speed of manufacturing and reduction of cost which will revolutionise the large scale manufacture of components, and even achieve sensational results in the field of human organ repair and transplants. 3D printing is not only used for printing small components - there are also gigantic printers for producing buildings. Some of these can be seen on: https://all3dp.com/1/biggest-large-3d-printer-world-most-expensive/ wn

A wide variety of materials are already available for 3D printing. These include plastics: Polyamide, Resin, ABS (Acrylonitrile butadiene styrene), High Detail Resin, Extreme Detail Resin and Alumide (nylon filled with aluminium dust).

Metals available: Stainless Steel, High Detail Stainless Steel, Brass, Copper, Bronze, Silver, Gold, Platinum, Titanium and Rhodium as well as a selection of ceramics.

The resolution attainable by 3D printing depends on the software resolution as well as the vertical and horizontal resolution of the printer. A resolution of 150 microns

Adidas steps into the future with its first 3d printed shoe design

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IN MY OPINION - KEVIN JACOBS

Looking at the Engineering Profession Holistically

BY | KEVIN JACOBS

Engineering is a term synonymous with solving problems, on both large and small scales, across various industries. Anyone outside of engineering generally considers the profession and loosely uses the term engineer to cover a generic skill set but this is not the viewpoint from within the industry. There is a reason there are limited numbers of engineering graduates, it is not an easy qualification to obtain and it has been disregarded outside the professional industry. The term engineer needs to be regarded in the same high esteem which it once was. Yes, there is a difference between a technologist, a technician and an engineer. A technologist studied technology and the applications, a technician can read schematics and used applied knowledge whereas an engineer is responsible for the driving technology to be implemented by technologists and technicians. This is where Government and Industry needs to work together to stop organizations from loosely using the word engineer and impose that positions be regulated based on certified and accredited qualifications. The loose use of the term, "engineer" undermines the professional organizations and associations which are formed around the profession. This should be a call to restore the professional integrity of the profession, Engineer. It should be mandatory that as an engineer, one gets registered with a professional Government backed institution and work towards professional registration.

What industry does not understand is that as an engineer, one is responsible for making decisions which effect lives and there are professional as well as liability criteria which needs to be considered. Professional associations back engineers to conduct their work responsibly and provide legal as well as indemnity insurance provisions to protect the engineers. Loosely using the term engineer gives the false rapport to clients that these protection schemes are in place for their employees and negligently account for employee responsibility. This limits the employee responsibility and accountability when conducting work under the title of, "engineer" when conducting work at a lesser role. This is a direct discredit to organizations incorrectly utilizing the said titles.

Holistic Engineering is the new revolution which needs to be considered in relation to engineering across all industries and technology spectrums. Holistic Engineering is the culmination of engineering solutions based on considering the best applicable solution for a given application considering all aspects in relation to personnel and equipment safety and the environment.

It is archaic thinking of engineering in isolation, due to the rapid amounts of technologies and external influences currently at play today. There is no industry today, which can say that engineering has stagnated to the point where it cannot be developed further. If these industries exist, then I challenge them to become obsolete within the coming years.

Holistic Engineering considers all aspects from engineering incorporating design, logistics, reliability, functional safety and the statutes of limitation, which need to be considered in the event of catastrophic failure.

Having worked in industry for several years, I have seen engineers working in isolation, and when all the services come together on large scale projects, there are minor to major influences which could have been avoided, had proper Holistic Engineering been considered. This stems from basic pipe clashes, having not reviewed 3D models correctly, or the models themselves not being modelled correctly, to fundamental safety concerns which could all have been avoided, prior to project implementation

had proper thought and considerations been given to basic engineering principles.

Holistic Engineering principles are a multi-stage approach for each engineering discipline to be exercised, by all the various discipline engineers, to their respective disciplines as well as collectively.

Each industry has inherent safety design principles, and with today's engineering technologies available, considerations need to be given, keeping in mind that in some instances system vulnerabilities could pose dynamic safety concerns, and these need to be designed for, and considered during all stages of the project.

The design philosophy behind Holistic Engineering is to consider all possible design elements. This includes static and dynamic conditions, keeping in mind safety as the main priority to both personnel and equipment, all while considering environmental impact limitations, and/or possible mitigation. Holistic Engineering should include the total life-cycle of the project including any environmental rehabilitation post project completion.

The dark art of industrial espionage has given rise to a new type of engineering which is called social engineering. It has fast become a quick way to attack unsuspecting victims into voluntarily handing over personal information, and then using the information to expose organisations. It is a very passive approach to hacking and anyone can fall victim. Large organisations with thousands of employees are at a greater risk, as you only need one victim to fall prey for the organisation to be at risk. Being social in today's era is to be connected. One cannot sustain a modern life without being social on some or other digital platform and/or the normal physical presence of conversation. The latter has fallen by the way side, given up to the amount of social media. Social engineering is the art of being a professional hacker and impersonator to exploit people and their organizations. It is a very dark art and the characters you deal with are not your typical shy, behind-the-scenes type of characters. They can appear to be friends, acquaintances or even strangers, striking up a conversation about your personal and/or work life. They may start a conversation about someone you know to get you feeling relaxed and gain your trust. The more personnel in your team the more vulnerabilities or potential threats to your team's cyber security. The social engineers of today have become social experts by using trust, to wilfully extract personal information from their victims through impersonation, or other means. The solution is not simple. The best an organisation can do is create awareness and run social engineering campaigns, to remind personnel of the potential dangers, as well as techniques often used by the social engineers. Basic awareness campaigns inform personnel not to pick up a flash drive lying around and plugging it into a computer, do not open the doors for strangers through access control, and do not divulge personal information to anyone outside of the organisation about oneself or the organisation. These seem to be simple steps, but social engineers expose this information by impersonating a staff member once they know key information about chains of command, and which levels of authority to exploit. The potential threats are tremendous, and it can tarnish the reputation of the organisation. Social engineers can obtain the entire organizations personnel personal files, and these identifies can be used for further impersonation, or sold off on the dark web for other identity related crimes.

Everyone needs to be careful, having fallen victim to social engineering; staying vigilant one must be protective about who you trust with your personal information.

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

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

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

We look forward to hearing from you.
- Ed

The impact of piecemeal site access given to an electrical contractor can impact on a project and this is something that needs to be clearly understood by all parties.

By way of introduction, it is necessary to understand the definition of disruption. Disruption (as distinct from delay) is a disturbance, hindrance or interruption to a contractor's normal working methods, resulting in lower efficiency.

Disruption is demonstrated by applying analytical methods and techniques to establish the loss of productivity arising out of the disruption events and the resulting financial loss. Disruption is not merely the difference between what actually happened and what the contractor planned. From the contractor's perspective, the objective of a disruption analysis is to demonstrate the lost productivity and hence additional loss and expense over and above that which would have been incurred were it not for the disruption events for which the employer is responsible. Many of the causes of lower than anticipated productivity (such as poor supervision or planning, re-work due to defects, inadequate coordination of sub-contractors, or over-optimistic tendering or tendering errors) will not justify compensation for disruption. It is only the consequences of disruption events that are the responsibility of the employer for which compensation might be payable to the contractor. The productivity loss caused by all other events must be excluded from the claim. Source : SCL Delay and Disruption Protocol 2nd Edition: February 2017.

QUESTION ONE

What is the difference between the tendered price and the actual expenses incurred on a project?

ANSWER ONE

The successful contractor would have provided a competitive price based on a predetermined "Scope of Works" in a clearly defined environment. The final tender price factors in clearly defined guidelines and rules by the employer or client.

A specific set of norms is used to determine each unit installation rate per unit quantity in the "Bill of Quantities" for rateable works. These are industry norms and priced for a continuous production and exclude any provision for disruption.

This tender price is further indicative of the "Management & Supervision" team necessary to complete the project with operational resources allocated over a period of time; it is based on the "Direct Field Labour" planned for this works.

Piecemeal access disrupts the production environment and destroys the validity of the assumptions used by the contractor when pricing according to the original guidelines and rules. As disruption occurs productivity becomes adversely affected.

Disruption claims relate to loss of productivity in the execution of particular work activities. Because of the disruption, these work activities are not able to be carried out as efficiently as reasonably planned (or as possible). The loss and expense resulting from that loss of productivity may be compensable where it was caused by disruption events for which the other party is contractually responsible.

Disruption events can have a direct effect on the works through this reduction in productivity; such as piecemeal site access different from that planned, out-of-sequence works or design changes. They can also lead to secondary consequences on the execution of the works; for example through crowding of labour or stacking of trades, dilution of supervision through fragmented work gangs, excessive overtime - which can also lead to fatigue, repeated leaming cycles and poor morale of labour which can further reduce productivity.

QUESTION TWO

What are the consequences of undiagnosed disruption events?

ANSWER TWO

The tendency of employers or clients to enforce the manpower loading as per the project plan sometimes places the contractor in a difficult situation.

When faced with a situation where the access on the ground does not agree with the employer's access projections, the contractor has some options. If the access is forecast to be delayed for some time, the contractor may choose to terminate the excess labour. Due to the cost, time and effort, this is not often done.

Another option is to remove the surplus labour from the site, and submit a claim for standing time. The danger here is that some progress is lost, albeit at a higher cost to the contractor. The labour force can also become negative, particularly when some have to work and others are allowed to stand idle.

The option very often taken by the contractor is to continue using its resources as best as possible, in the interests of making progress to meet the employer's completion date/s. This is not only inefficient, but also costs more than what was provided for in the tender.

Sometimes, in an effort to maintain the relationship with the employer, the contractor delays the contemporaneous submission of "Disruption Claims" and this often results in disputes.

Contractors, inexperienced in contract law, attract contractual risks and losses of revenue as a result of disruptions. Loss of revenue and cash flow issues also result from late reaction to identifying potential disruption and timeous analysis thereof. The contractor's risk increases as the works near completion and disruption analysis is delayed. wn

Information provided by Zest WEG Group

August

Movers, shakers and history-makers

COMPILED BY JANE BUISSON-STREET
FSAIEE | PMIITPSA | FMIITSPA

1 AUGUST

1970 During a study, the US Atomic Energy Commission connected a computer across the transatlantic to determine whether a database could transfer data overseas. One computer was in Paris and the other in California, USA. The group concluded that this was a global success.

2 AUGUST

1887 Birthday of Thomas Alfred Ward, born in India, a South African cricketer who played in 23 Tests from 1912 to 1924. He died in 1936 as a result of accidental electrocution while working at a gold mine.

3 AUGUST

1993 Apple introduced the Newton MessagePad, one of the world's first Personal Digital Assistants (PDA). The term PDA was first used by Apple CEO John Scully in 1992.

4 AUGUST

1991 The Greek cruise ship MTS Oceanos sank off the Wild Coast of South Africa. She sank during a storm which caused leaking in the engine room.

5 AUGUST

2013 Jeff Bezos purchased the Washington Post for $250 million dollars. Bezos is an American technology and retail entrepreneur, investor, and philanthropist who is best known as the founder, chairman, and chief executive officer of Amazon.

6 AUGUST

1844 South African James Henry Greathead was born. He was a civil engineer renowned for his work on the London Underground railway, particularly the design of the Barlow-Greathead shield which consisted of an iron cylinder 2.21m in diameter which was fitted with screw jacks which enabled it to be jacked forward.

7 AUGUST

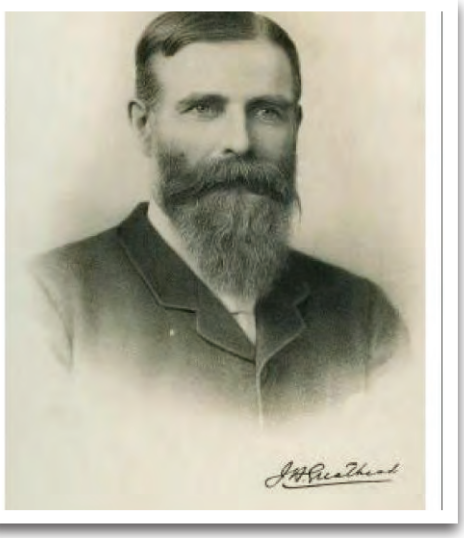
1917 South African born Squadron Commander Edwin Harris Dunning of the British Royal Naval Air Service, was the first pilot to land an aircraft on a moving ship, the HMS Furious. Sadly, he was killed five days later during his second landing attempt, when an updraft caught his port wing, throwing his plane overboard.

8 AUGUST

1999 This was the first day of office for Tito Mboweni as the President of the South African Reserve Bank. He had been inaugurated the previous night.

9 AUGUST

1965 The SA Cricket Team beat England in the second test in Nottingham (England), thereby scoring the first victory over the English in ten years.



10 AUGUST

1965 Karen Muir (born and raised in Kimberley, RSA) became the youngest official world record-holder in swimming history when the 12-year-old recorded 68.7 sec for the 100 m backstroke at the Derby Baths, Blackpool, England. She became not only the youngest world record-holder in swimming, but she is, up to now, the youngest athlete ever to set a world record in any sports code.

11 AUGUST

1999 Red Hat, a Linux distribution and a vendor, went public and achieved the eighth-biggest first-day gain in the history of Wall Street. They are listed on the S&P 500 company list. This company has provided a more professional type of open source software.

12 AUGUST

1819 Grahamstown, RSA, was founded.

13 AUGUST

1963 Edward Roworth, a British born South African landscape painter, died in Somerset West. He arrived in South Africa with British forces during the Anglo-Boer War. When the war over he decided to stay, and settled in Cape Town, where he set up a teaching studio.

14 AUGUST

2008 55 Netflix distribution centres went offline due to an "undisclosed error". While they have never publically made the reason known, they did say that it only affected the core of mail-based delivery operations. The problem took 3 days to fully resolve.

15 AUGUST

2004 The South African 4 x 100m men's relay team won the gold medal for SA at the Olympic Games in Athens. The South African squad of Roland Schoeman, Lyndon Ferns, Darian Townsend and Ryk Neethling clocked 3 minutes and 13.17 seconds to triumph over the Netherlands and the US teams.

16 AUGUST

1800 The Cape Town Gazette and African Advertiser, a bilingual newspaper and the first to publish news and advertisements, was published for the first time.

17 AUGUST

1996 History was made in Western Africa when, for the first time, a woman, Ms Ruth Sando Perry, was unanimously elected at a meeting of West African Heads of State to become the 3rd Chair of Liberia's Ruling Council. She died 8 Jan 2017.

18 AUGUST

1947 Hewlett-Packard was incorporated by William Hewlett and David Packard, nine years after they sold their first products from their garage in Palo Alto. Hewlett and Packard got their start in 1938 by producing oscillators used to test audio equipment. Since selling eight of their first oscillators to Disney for use in preparing movie theatres for the movie Fantasia, HP grew to be one of the largest technology companies in the world.

19 AUGUST

2004 Google held its Initial Public Offering (IPO) and sold over 22 million shares at a starting price of $85. Google shares closed that day at $100.34, and the IPO created many instant millionaires and a few billionaires.

20 AUGUST

1911 The New York Times sent a telegram message to test how fast a commercial message could be sent around the world. Reading simply, "*This message sent around the world*". It was originally transmitted at 7pm, travelled over 45 062 kms and was relayed by 16 different operators. It arrived back at The Times only 16.5 minutes later.

AUGUST

continues from page 61

21 AUGUST

1993 NASA lost contact with the Mars Observer spacecraft, three days before it was to enter into orbit around Mars.

22 AUGUST

2010 The iconic Athlone cooling towers, also know by locals as "The two ladies of Athlone", were demolished in just eight seconds during a "surprise" implosion by the City of Cape Town.

23 AUGUST

1975 The new campus of the University of Port Elizabeth (now part of the Nelson Mandela Metropolitan University) was inaugurated during sumptuous festivities.

24 AUGUST

2007 South Africa's Gold-Panning Team returned home, with one gold and two bronze medals, from the World Gold Championships in Slovakia.

25 AUGUST

2017 The official videogame of the 2017 FIA FORMULA ONE WORLD CHAMPIONSHIP™, will release onto PlayStation®4 computer entertainment system, Xbox One and Windows PC (DVD and via Stream) worldwide.

26 AUGUST

1929 Major Allister Mackintosh Miller secured a government subsidy and introduced the first official commercial air service in South Africa under the name of Union Airways Company (Pty). The first flight was between Maitland and Port Elizabeth and the cargo was 5 bags of mail.

27 AUGUST

1950 The BBC transmitted the first ever live television pictures across the Channel.

28 AUGUST

1965 Wendy Botha, 4-times World Surfing Champion, was born in East London. She began surfing at the age of 13, and won four consecutive South African National Championships between 1981 and 1984.

29 AUGUST

1969 The first Interface Message Processor (IMP) was delivered to Leonard Kleinrock's research group at UCLA. The IMP was the device that interconnected networks between research facilities on the developing ARPANET, the precursor to the Internet.

30 AUGUST

2004 Group chief executive Maanda Manyatshe announced that the SA Post Office had finally delivered an operating profit of R27 million. Apparently, this was the first profit after 200 years.

31 AUGUST

1902 In one of the worst winter storms ever, 18 ships were wrecked in Algoa Bay, Port Elizabeth. Fifty eight lives were lost that day. wn

calendar

AUGUST | SEPTEMBER | OCTOBER 2017

AUGUST 2017

2 - 3	Internet of Things (IoT)	Johannesburg	roberto@saiee.org.za
3 - 5	NOCCI Business Expo	Kimberley	www.nocci.co.za
4 - 6	Empire Money Expo	Johannesburg	www.themoneyexpo.co.za
7 - 9	Rapid Underground Mine and Civil Access Conference	Johannesburg	www.saimm.co.za
11	Application of LV Frequency Control to Industrial Drives	Johannesburg	roberto@saiee.org.za
14 - 16	Industrial & Commercial use of Energy Conference	Cape Town	www.energyuse.org.za
15	Smart Buildings & Infrastructure Western Cape Summit	Cape Town	www.smart-summit.com
16	ELPA Examination	Midrand	www.elpa.org.za
16 - 17	Fundamentals of LTE Mobile Communication	Johannesburg	roberto@saiee.org.za
16 - 17	Fundamentals of Power Distribution	Johannesburg	roberto@saiee.org.za
17	ELPA Examination	Midrand	www.elpa.org.za
22	ELPA Examination	Midrand	www.elpa.org.za
23	ELPA Examination	Midrand	www.elpa.org.za
23 - 24	Incident Investigation & Management (Including Root Cause Analysis)	Johannesburg	roberto@saiee.org.za
23 - 24	Fundamentals of Developing Renewable Energy Plants	Johannesburg	roberto@saiee.org.za

SEPTEMBER 2017

5	SAIEE Chairty Golf Day	Glenvista Golf Course	www.saiee.org.za
6 - 7	Design Of Economical Earthing Systems	Johannesburg	roberto@saiee.org.za
12 - 15	Advanced Microprocessor Based Power System Protection Course	Johannesburg	roberto@saiee.org.za
13 - 14	Microsoft Project Professional	Johannesburg	roberto@saiee.org.za
14	65th Bernard Price Memorial Lecture	Nationwide	www.saiee.org.za
19 - 21	SAIEE SmartGrid Conference	Midrand	www.saiee-smartgrid.co.za
19 - 22	Managing Projects Effectively	Johannesburg	roberto@saiee.org.za
20 - 21	Photovoltaic Solar Systems	Johannesburg	roberto@saiee.org.za
26	Fluke Proactive Maintenance Training	Johannesburg	www.saiee.org.za
29	Western Cape Centre Dinner & Dance	Cape Town	www.saiee.org.za

OCTOBER 2017

3-5	FTTH Council Conference	Cape Town	www.ftthcouncilafrica.com
9-11	International Water Association IWA Specialist Conference (IWAIWASP)	Skukuza	www.iwa-network.org
17-18	African Rail Evolution (ARE)	Durban	www.rail-evolution.com
22	AfrikaBot	Centurion, JHB	michael@uj.ac.za
27	SAIEE Annual Banquet	Wanderers	www.saiee.org.za

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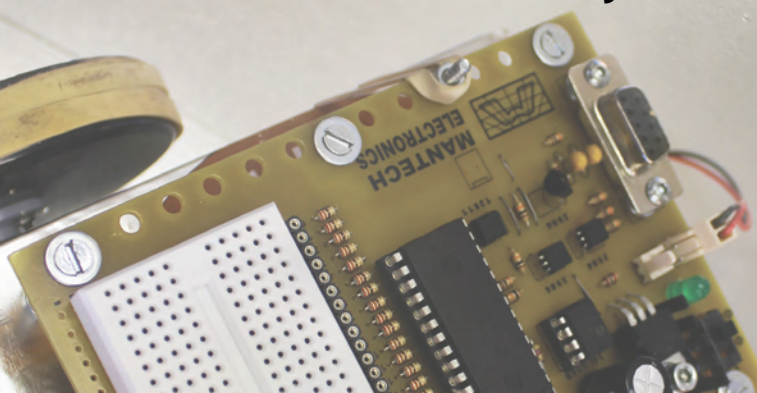

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