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It is April, and we are starting to feel the change of the season, but I must also add that in South Africa, I think we are beginning to lose two seasons. If I remember back in the past year, we didn't have a winter last year (in Johannesburg) with only a week of icy weather, and we missed Spring. I'm sure this year will not surprise that we will enjoy a very mellow winter, and wake up one morning and it's summer. Aren't we lucky?

This issue focusses on Aerospace - which is another ball-game. The first feature article, on page 22 is about Machining Titanium for the Aerospace industry. It is somewhat interesting to learn that aircraft companies are taking strides to streamline their fleets to operate more efficiently.

The next feature article on page 28 discusses the amount of Space Junk outside our atmosphere, and how there is a race on between the United States and the United Kingdom on who will come up with the better plan to remove all the debris.

I put together an article on the Mission to Mars (pg 34) which tells you all about the launch of the programme, right through to what the plans are for establishing a human settlement on Mars. The countdown has begun, and countries from all over the world are part of this historic endeavour.

Well, you have a jam-packed issue here.

I will be jumping right into the May issue, which will be available at the African Utility Week, taking place from 15 - 17 May in Cape Town. We will be there, and please pop into our stand and come and say hello.

Here's your April issue - enjoy the read!

Minx

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

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JACOB MACHINJIKE
2017/8 SAIEE PRESIDENT

The theme of the month is aerospace, and I recall the giant leap of man into the sky when the Wright brothers had their first flying experience, Neil Armstrong walking on the moon, NASA, Soviet and Chinese space explorations and programs, amongst numerous initiatives by others.

Taking a flight from one city to another seems to be a regular experience for many and the safety and convenience that goes with it.

Engineer Elon Musk recently said, *"I think the future is vastly more exciting and interesting if we are a spacefaring civilization and a multi-planet species than if we're not"*. It sounds like the sky is *(not)* the limit!

Improvements in the sphere of engineering control and automation have made significant strides in airborne technologies.

Design, evaluation and flight testing of a gain-scheduled autopilot for a missile system, a space shuttle, airplanes or other aircraft is revolutionising the future.

Advances in software, electronics and motor technology in recent years have led to the development of small and low-cost Unmanned Aerial Vehicles (UAVs). The most common type of UAVs is the quadrotor or quadcopter, among other multi-rotor unmanned aircraft, popularly known as drones. They are a favorite platform for hobbyists and research laboratories, and it is increasingly in use as observation platforms for some roles. Probably the most common application is for aerial photography while surveillance is also a much-suggested use. The main reasons for this appear to be their mechanical simplicity compared to traditional rotorcraft, which means little cost, short time to execute and personal safety advantages. For all applications, hovering is an essential requirement. It is vital that the aircraft is resistant to transient winds and gusts particularly for operation in urban areas where there is a likelihood of collisions with buildings and other infrastructure.

As this article marks the end of my term, I found the SAIEE Presidential flight and journey quite enjoyable, sometimes bumpy but smooth due to committed team players. The flight plan is that you get elected as a Junior Vice President for a year to add value, observe, learn, be coached and mentored. Then the flight plan changes in the ensuing years, to a higher altitude of Senior Vice, and then to Deputy President level.

When you reach the Presidential level, there is a feeling of euphoria to lead and serve the members of a well-respected organization, which is older than the African National Congress (ANC). An Institute whose members at the time, influenced the formation of Eskom in 1923, as well as helped to give rise from previous forms of statutory mandated engineering bodies to the current Engineering Council of South Africa (ECSA) prescribed by the Engineering Professions Act of 2000.

Taking our members to greater heights in their careers and profession is paramount, and this is ingrained in our vision and our purpose as we focus on providing coaching and mentorship on a bigger scale, as we convert 'caterpillar-like' engineering learners into 'spectacular butterfly' electrical engineering practitioners.
The sky is *(not)* the limit, indeed!

J Machinjike | SAIEE President 2017
Pr. Eng | FSAIEE

WATTSUP

SAIEE INAUGURATES NEW PRESIDENT

The SAIEE inaugurates a new President.
From left: Jacob Machinjike (2017 SAIEE President) and 2018 President Dr Hendri Geldenhuys.

The Africa Research Journal Best Paper Award winners.
From left: Dr Wynand van Staden, Jacob Machinjike (2017 SAIEE President) and Prof Etienne van der Poel.

At the recent Annual General Meeting, which took place at the South African Military Museum at the end of March 2018, the South African Institute of Electrical Engineers had a change of leadership, with 2017 SAIEE President, Jacob Machinjike handing over the baton to Dr. Hendri Geldenhuys.

The first order of the evening was the SAIEE Best Paper Annual Award, published in SAIEE's peer-reviewed Africa Research Journal. The winners are Dr. Wynand van Staden and Prof Etienne van der Poel from UNISA for their paper *"Using Automated Keyword Extraction to Facilitate Team Discovery in a Digital Forensic Investigation of Electronic Communications"* which appeared in the June 2017 issue.

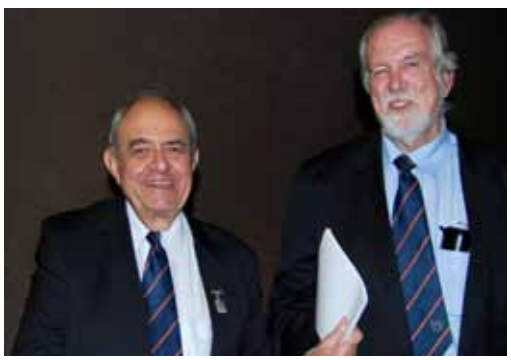
After Dr. Geldenhuys's inauguration as the 2018 President, he announced the 2018 Office Bearers. They are George Debbo, Deputy President; Sy Gourrah, Senior Vice President; Prof Sunil Maharaj, Junior Vice President; Jacob Machinjike, Immediate Past President; Viv Crone, Honorary Treasurer; and Veer Ramnarain, Honorary Vice President.

Geldenhuys proceeded with his inaugural address, *"The SAIEE Challenge: The World is Changing."* To ensure the prosperity of the SAIEE for the next century, we need to understand our current situation and plan for a legacy.

Read the article next month on page 6 in the May issue of **watt**now.

2018 President, Dr Hendri Geldenhuys with Prof Sunil Maharaj, 2018 Junior Vice President.

2018 President, Dr Hendri Geldenhuys with Veer Ramnarain, 2018 Honorary Vice President.



George Debbo (2018 Deputy President) with Mike Cary (Past President).

From left: Kgomotso Setlhapelo, Prudence Madiba, Mapula Majola, Amelia Mtshali, Gladys Machinjike, Jacob Machinjike (Immediate Past President) and Maanda Ramatumbu.

Movers & Shakers - from left: Prof Fulufhelo Nelwamondo, Nduduzo Khumalo, Teboho Machabe, Prince Moyo, Dr Hendri Geldenhuys (President), Kgomotso Setlhapelo, Jacob Machinjike (Immediate Past President), Lehlohonolo Mashego & Pascal Motsoasele.

Dr Hendri & Elmarie Geldenhuys with Gladys & Jacob Machinjike.

Dr Angus Hay and Kgomotso Setlhapelo.

Chris Yelland and Sy Gourrah (Senior Vice President).

Viv Crone (Honorary Treasurer) and Ian McKehnie (Past President).

The SAIEE Audio specialists: Douglas Muller & Lerato Mulovhedzi

Prof Sunil Maharaj (2018 Junior Vice President) with Prof Pat Naidoo (Past President).

WATTSUP

ACTOM attains Level 1 B-BBEE status

ACTOM has attained a Level 1 rating under the government's revised Broad-Based Black Economic Empowerment (B-BBEE) regulations and amended Codes of Practice.

The group, which attained the new rating on February 9 this year following auditing of its B-BBEE status by a SANAS-accredited verification agent for the financial year to end-March 2017, previously had a Level 3 rating.

ACTOM is the only company in its industrial sector that currently enjoys Level 1 B-BBEE status.

"The upgrading of the group to Level 1 is chiefly attributable to the advances we have achieved in Skills Development during the year under review, due to the extensive training that the group undertakes," commented Mervyn Naidoo, ACTOM's Group CEO.

For companies to obtain their B-BBEE rating, they are assessed on five essential elements, of which skills development is one element. In the latest audit, ACTOM also scored well on three of the other four primary factors, namely Ownership, Enterprise & Supplier Development (ESD) and Socio-Economic Development (SED).

In addition to the new B-BBEE rating is the recent increase in the group's black-empowerment shareholding to 51,3% and of the black women shareholding to 34,66% – these previously being 32,5% and 11,5% respectively.

Andries Mthethwa, ACTOM's Deputy Chairman, said the combined effect of the group's Level 1 B-BBEE rating and its optimum black-empowerment shareholding status is to place it in the highest available position to do business with SOE's and municipalities for meeting their black empowerment requirements.

"In addition to this they also enhance our standing with other private sector companies, since they, like us, are actively encouraged by the B-BBEE legislation to do business with accredited black-empowered companies to enhance their B-BBEE standing with the authorities and hence the SOE's," he said.

Mervyn Naidoo
Group CEO | Actom

"This consideration applies especially to our Level 1 status, as it means that another private sector company that does business with us will gain higher B-BBEE procurement credits than when dealing with a company that has a lower B-BBEE rating," Mthethwa concluded.

New portfolio director for KZN Industrial Technology Exhibition

Nick Sardanas

In order to provide maximum exposure for the KwaZulu-Natal industrial Technology Exhibition (KITE) 2019 event and its exhibitors, Specialised Exhibitions Montgomery has appointed experienced portfolio director Nick Sarnadas to head up the team.

Sarnadas, who is also responsible for the Hostex, Markex and Frigair exhibitions, has been in the hospitality industry in various forms for over 16 years, both locally and abroad. He has a degree in communications and joined Specialised Exhibitions Montgomery in 2014 as Food and Hospitality Event Director.

"We have already reserved 42% of the stand space for KITE 2019, which is taking place between 24 and 26 July 2019 at the Durban Exhibition Centre, and regular enquiries are keeping us on our toes," says Sarnadas.

The manufacturing sector remains a critical element within the region's GDP and this was underlined by the Durban Chamber of Commerce and Industry's CEO, Dumile Cele, stating that KwaZulu-Natal needs to be more confident in its own offering.

For more info visit www.kznindustrial.co.za.

Nigeria: Africa's prime power development hotspot

Nigeria offers a wealth of power sector business opportunities, with industrialists actively seeking generation and distribution solutions to power their business growth.

Paul Runge, Director Projects & Development Finance at research and consulting specialists Africa House, reports that his recent missions to Nigeria have revealed numerous opportunities for power sector businesses, particularly those operating in the renewable energy, solar energy, power storage, technical and training and specialist financial consulting arenas.

Africa House, also the research partner of the premier African power sector conference and exhibition, POWER-GEN & DistribuTECH Africa, believes Nigeria is currently a hotspot for power industry development.

"With a population officially in the region of 186 million, serious power challenges and massive industrial growth potential, Nigeria is actively seeking new and viable power solutions to drive economic growth," says Runge.

The Manufacturers' Association of Nigeria is among the organisations looking to alternative power solutions; since its members face growth constraints due to unstable grid power. *"Some areas have grid power for only 9 – 16 hours a day. This could cause serious problems for industries like smelters or manufacturers. To overcome downtime, most manufacturers invest heavily in diesel generators, which adds to their bottom line costs. They are looking to renewable energy and hybrid solutions to assure power supply and support their growth,"* he says.

In Nigeria, where components of the power ecosystem have been privatized, generation companies and distribution companies face certain operational challenges, including fixed power tariffs, Runge notes. However, these challenges present opportunities for suppliers and service providers who can support lower cost, more efficient operations, advanced new technologies and enhanced technical skills.

"In particular, we noted strong interest in advanced solar panels, battery storage technologies and high voltage cables during our recent talks in Nigeria," says Runge. *"But Nigeria is characterized by a vibrant, innovative entrepreneurial culture, where stakeholders are keen to explore any business partnerships that can drive genuine business value. So while many still consider Nigeria to be a challenging market, we see it as a country rich with growth potential."*

Hoping to foster beneficial business partnerships in Nigeria, Africa House has included delegates from several key Nigerian power organisations in the sub-Saharan VIP delegation to be invited to attend POWER-GEN & DistribuTECH Africa 2018 and to participate in the event's B2B meetings.

The sub-Saharan VIP programme is a highly successful initiative that sees PennWell hosting up to 80 VIPs from across sub-Saharan Africa at POWER-GEN & DistribuTECH Africa, giving both the VIPs and conference delegates a rare opportunity to network and discuss potential partnership opportunities across Africa.

Sue Bowden, Senior Research Executive at Africa House, reports that over 40 senior engineers, project managers and decision-makers in key power development regions have been identified for invitations to participate in this year's sub-Saharan VIP delegation.

For more info, visit powergenafrica.com

WATTSUP

CUMMINS' DEMANDING PRESENCE AT MEE 2018

Cummins introduced the new C450 D5, as part of its QSG12 series diesel gensets for the commercial and industrial markets, at Middle East Electricity (MEE) 2018 in Dubai recently. This latest product offers more power for less space by delivering a much higher power density and a more reliable power solution.

The series is available from 400 kVA to 450 kVA, powered by a Cummins four-cycle, inline, six-cylinder dual-speed diesel engine offering more robust performance using less fuel. Additional features include extended service intervals of 500 hours, a lower fuel consumption, and unaided cold-start capability at 12 °C.

The new 9.5 litre G-Drive Coolpac series was showcased in the newly-released Cummins black colour. The 6LTAA9.5-G1 G-Drive Coolpac model, available at 350 kVA, offers higher efficiency and dependability. With a 24-valve and a larger-flow injector design, this new model delivers one of the highest power-to-weight ratio in its class.

Cummins displayed its Digital Master Control 8000, a fully-automatic, distributed logic controller for remote applications, making it easier for users to integrate and adapt their varying power needs. The new system can control diverse power sources such as solar, genset, and wind. With available remote access and monitoring, users can access the control system securely, and view up to 90 days of data logging anytime, anywhere.

Cummins also launched a virtual reality experience at MEE 2018, which allowed users to step inside a generator plant room and connect a complete power system. Alok Joshi, Cummins Power Generation, Director, Africa and Middle East, commented that the exhibition was a perfect platform for Cummins to debut its latest innovations for the power-generation sector.

For more info, visit cummins.com

Taking Stock – reflecting on progress and what lies ahead

The year 2018, understood in some circles as the year of a "new dawn" marks seventeen years of the Coega Development Corporation (CDC) operations. Reflecting on the years spent navigating a turbulent economic environment, the country's industrial development programme has recorded significant achievements coupled with some significant advances over the years.

Equally, the introduction of the Special Economic Zone (SEZ) Act replacing the Industrial Development Zone (IDZ) regulations, which had been the tool that governed IDZs in South Africa, introduced another dimension, the concept of an integrated ecosystem.

The integrated ecosystem approach, initially explored by the Chinese in the early 1980s, saw the establishment of the first Economic Development Area. Some of the zones having achieved success, with the Tianjin Economic-Technical Development Area (TEDA) and the Shenzhen Economic Development Area being the most successful.

The adaptation of the concept into the SEZ act seeks to boost private investment (domestic and foreign) in labour-intensive areas to stimulate job creation, competitiveness, skills, and technology transfer as well as increasing exports of beneficiated products through the establishment of special economic zones.

The CDCs growth trajectory over the past five years has seen it diversify its core targeted sector approach and investment market target to incorporate the changing global landscape. This has seen the organisation surpassing the double-digit growth in new investments for three consecutive years.

EE PUBLISHER'S ANNUAL PARTY

EE Publishers recently held its annual client luncheon which was a huge success, not least due to the outstanding presentation by Dr. Imtiaz Sooliman, founder of Gift of the Givers.

Dr. Sooliman has received numerous awards for his tireless humanitarian efforts to provide relief in disaster areas worldwide. His account of the tragic circumstances he and his team found in war-torn or natural disaster areas and the medical and logistical solutions he provided was genuinely moving and inspiring.

His most recent award is an honorary doctorate from Stellenbosch University as part of its centenary commemoration.

Andries Mthetwa (SAIEE Past President) and George Debbo (SAIEE Deputy President) in attendance.

From left: Dr Sooliman, Gift of the Givers; Annette Cloete and Chris Yelland (EE).

From left: Mmule Setati, NGAGE; Minx Avrabos, wattnow magazine; and Jonathan Ducie, NGAGE.

The ABB team.

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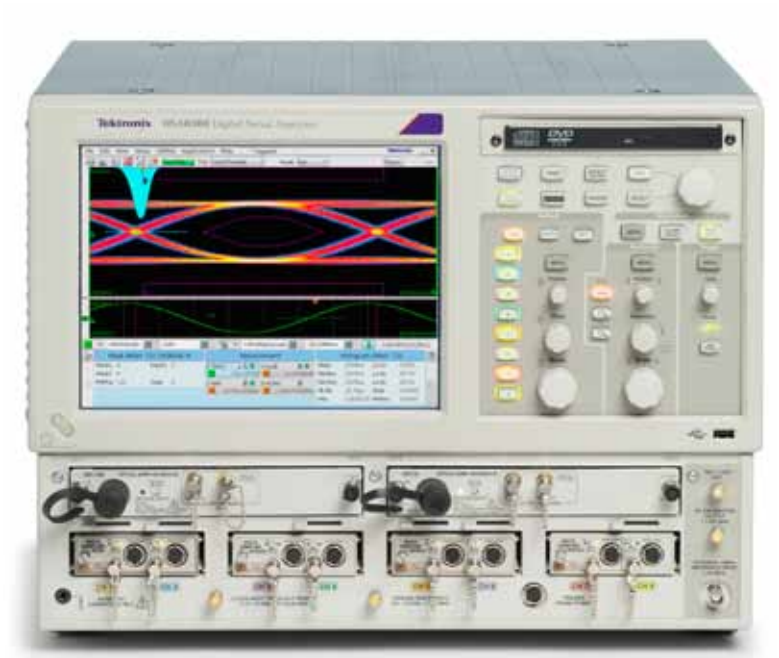

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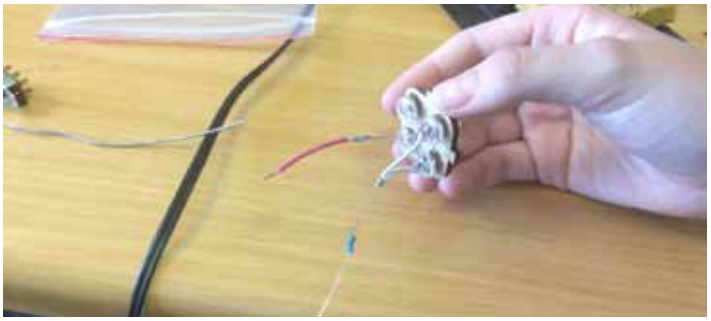
WATTSUP

North West University - Femmegineering Day



North-West University (NWU) in Potchefstroom recently hosted their annual Femmegineering Day.

The Faculty of Engineering saw ±200 grade 10's to 12's from various schools in the region visiting project sessions. The **watt**now magazine was invited to attend the day and was privileged to see how the girls build torches in the electrical engineering department. It was a fun day for all.

A gala event took place later that evening with Prof Liezl van Dyk, Executive Dean: Faculty of Engineering opening the event.

The guest speaker was Dr. Hannelie Nel who is the Managing Director of Tennelli Industries (Pty) Ltd, a company that focuses on innovation in engineering and education. Currently, she serves as Visiting Associate Professor at the Faculty of Engineering at North-West University, and as academic in the Postgraduate School of Engineering Management at the University of Johannesburg.

Red Wine Acoustics and Annelu Le Roux looked after the entertainment for the evening, which had the girls dancing in their seats.

Jolache Couture from Potchefstroom showcased her beautiful evening gowns for the matric farewells later in the year.

Dr. Leenta Grobler, Senior Lecturer, Faculty of Engineering, NWU and organiser of the event said *"Every year this event get's bigger and better, which is wonderful. The Engineering Council of South Africa (ECSA) said that professional women engineers totaled only 4%. We want to increase this percentage, and it is our job to make the girls aware of the global engineering possibilities."*

Unlocking Winning Partnerships Through Improved A-CDM

Thabani Mthiyane, ATNS CEO, CANSO Global Executive Committee Vice Chair & CANSO Africa Region Chairman.

Managing approximately 10% of the world's airspace, the Air Traffic Navigation Services (ATNS) plays a vital role in air traffic management and air traffic training within the African continent. ATNS recently hosted the Civil Air Navigation Services Organisation (CANSO) Africa Region Collaborative Decision Making (CDM) and Airport Collaborative Decision Making (A-CDM) Symposium in Durban, South Africa, in association with the CANSO and International Civil Aviation Organization (ICAO).

According to ICAO, CDM is defined as a process focused on how to decide on a course of action articulated between two or more community members. Through this process, Air Traffic Management (ATM) community members share information related to that decision and agree on and apply the decision - making approach and principles. The general aim of this process is to improve the performance of the ATM system as a whole while balancing the needs of individual ATM members across the industry.

"We understand that CDM is so much more intricate than just making the decision together," said CANSO Global Executive Committee Vice Chair, CANSO Africa Region Chairman, and ATNS CEO Thabani Mthiyane. *"We know that this does not mean that one size fits all, but what it certainly highlights is the need for constant and effective communication across the various stakeholders within the industry."*

The Symposium created a platform for various African aviation stakeholders to come together and share different insights and information and to look at best practice, versus current implementation. *"It is vital that as the aviation community, we have these platforms that create an open and honest dialogue. This will allow us to learn from one another, determine critical areas that need applications of new and improved principles and finally ensure buy-in from community members so that we can create a more efficient, safer service,"* said Mthiyane.

He added: *"CDM aims to create a community that can share information, which ultimately leads to better decision making. It also allows diverse stakeholders to empower each other with increased knowledge and information that creates common situational awareness levels, leading to stronger relationships that creates trust"*.

Mthiyane reiterated CANSO's global stance in assisting its members in implementing the CDM and A-CDM concept and processes and supporting collaborations that are committed to improving the efficiency of global air transport. *"It is for this reason that this major global aviation organisation has developed a guide to its foremost key stakeholders in the aviation industry. This guide outlines topics for consideration such as the involvement of relevant stakeholders in the regional and local development and implementation initiatives, and by providing practical A-CDM information and support in regional seminars and workshops."*

Airport Collaborative Decision Making as a concept is geared towards improving Air Traffic Flow and Capacity Management (ATFCM) at airports by reducing delays, improving the predictability of operations and optimizing utilization of resources.

A-CDM is about the partnership between airport operators, aircraft operators/ ground handlers, Air Traffic Controllers (ATCs) and Central Airspace Management Units (CAMUs), working seamlessly together in ensuring efficient operations and information and data sharing.

WATTSUP

TALK TO THE EXPERTS WHEN SIZING TRANSFORMERS

The WTA mini substation production line.

A range of factors need to be considered when correctly sizing a transformer for optimal performance in any application, according to Ronaldo Bertoldi, engineering manager at WEG Transformers Africa (WTA).

Ranked among the largest manufacturers of transformers in South Africa – and serving a range of sectors including mining, industry and agriculture – WTA is a leader in distribution transformers, power transformers and mini substations.

"Sizing a transformer for a particular application can be done using a simple equation, but the selection process requires many other factors to be taken into account," says Bertoldi. "Determining the right transformer for the job requires an in-depth assessment of the conditions under which the transformer will operate."

He emphasises the difference between the full load current required by an application, and the start-up current if there is a direct online starting process. If the motor is initiated by a direct online start, this part of the operation could require a much higher current than when it is running.

Bertoldi also points out the significance of the distance between the source of the power and the equipment consuming the electricity, as will be a voltage drop that will affect the sizing of the transformer.

"Transmitting low voltage over long distances can also be more expensive due to the thicker cables required by the higher current," he says. "Users can achieve a more cost effective solution in many cases by considering a step-up, step-down configuration, where the voltage is increased to facilitate longer distances, then reduced to the requirement of the equipment at its point of location."

WTA's years of expertise in manufacturing and repair equips it well to advise customers in the sizing and selection of the right transformer for their specific needs. Its Heidelberg facility is capable of locally manufacturing power transformers up to 40 MVA in voltages up to 132 kV as well as mini substations and ring main units. All distribution and power transformers are manufactured to SANS 780, BS 171 and IEC 60076 specifications under ISO:9001 quality standards.

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ELPA contrasts the US

This figure is according to a year-end report published recently by the National Oceanic and Atmospheric Administration (NOAA), which cited a total of 16 deaths across the US., which was seven fewer than the previous record low of 23 (2003) and significantly below the previous year's total of 39 for 2016. Lightning fatalities in America first started being recorded in the 1940s.

When lightning fatalities first started being recorded in America, the annual number of deaths reached as high as 432 in 1943. Following the institution of the American National Weather Service's (NWS) Lightning Safety Campaign in 2001, about 55 lightning deaths occurred each year, based on the previous 10-year average. That death toll has now been reportedly cut in half, as the current 10-year average is 27 deaths per year.

"When you consider the geographic size and population figures of the United States as a country, these latest figures are highly commendable," says Trevor Manas, the national director of South Africa's Earthing and Lightning Protection Association (ELPA). *"The continuing trend in the drop in the lightning fatalities figures in the United States is ascribed to improved educational outreach and public awareness, as the American public has been made aware of the dangers of lightning and knowing when and where to find shelter.*

"In contrast, South Africa has a disturbingly high number of lightning fatalities annually. While the average number of local annual lightning deaths is not always easy to estimate, the South African Weather Service has nonetheless estimated a figure of over 300 recorded deaths every year, while acknowledging that this figure could, in fact, be skewed higher. The fact that South Africa has some 300 actual annual recorded deaths, as verified by mortuaries, is a serious cause for concern."

Manas says that ELPA is determined to implement all programmes necessary, including educational, in its quest to become South Africa's recognised National Professional Body for earthing and lightning protection and make serious inroads into the improved protection of life and property. ELPA was officially established in June 2017, after two years of hard work by lightning protection industry experts from around the country, and is supported by various institutions such as Wits University, the South African Institute of Electrical Engineers (SAIEE) and the Department of Labour.

A professional body, by definition, is usually a non-profit organisation seeking to further a particular vocation, the interests of individuals engaged in that profession and the public interest. Many professional bodies are involved in the development and monitoring of specialist educational programmes and the updating of skills. They, therefore, carry out certifications to show that a particular individual in that industry possesses the necessary qualifications.

In this regard, Manas comments, *"ELPA aims to assist with providing industry*

Last year, lightning deaths in the United States reached an all-time low in that country's recorded history.

accreditations, certification, and benchmarks for quality of design and installation, as well as information and education on lightning safety."

He notes the following aims and projects carried out by ELPA in its short history thus far:

- Certification exams for lightning protection installers, lightning protection design and surge protection installations for electricians who carry out surge protection installations.
- Other certification exams will follow during 2018, including the first course for testers/assessors of lightning protection systems (LPSes). These exams have been linked to the launch of the ELPA Certificates of Compliance (COC) programme in late 2017. The COC programme involves the inspection of LPSes that are registered by ELPA accredited installers and designers. An expected inspection rate of 100 percent of all registered projects is anticipated.
- Noting that much of South Africa is subject to high lightning ground flash density, with a consequent wide-ranging need for the installation of LPSes, ELPA is making use of online facilities in a bid to nationalise some of its courses. Installation accreditation is the flagship online accreditation project, to accommodate the substantial number of candidates from around South Africa who want to take the ELPA installation exam.
- In addition to the LPS certification exams for designers, installers, and inspectors, ELPA will implement a CPD programme to boost electrical engineers in the science of lightning protection. Manas notes, *"This would be extremely valuable to all electrical engineers, as lightning protection is not a subject included in an electrical engineering degree in South Africa, and is normally only offered as part of a post-graduate high voltage study programme."*

Finally, in demonstrating its ongoing commitment to becoming the recognised National Professional Body for earthing and lightning protection, an ELPA delegation, including Manas and Richard Evert, recently attended the annual conference of United Lightning Protection Association (ULPA)/LPI (Lightning Protection Institute) in Florida in the United States.

"ULPA in the United States was founded in 1936 and as such is now in its 82nd year. It was a great privilege for ELPA to be able to attend this world-renowned body of lightning expertise and learn from those who have such a long official history within the lightning protection industry. Saying that we shouldn't underestimate the expertise that is present in South Africa and the ground-breaking lightning research that has taken place in our country since the middle of the 20th century, through some of the very partners – such as Wits University, for example – that ELPA is proud to partner with. The conference was a very satisfying experience, and we at ELPA look forward to continuing our work during 2018 and growing our national presence even further," concludes Manas. wn

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

SpaceX unveils Mars city plan, will fly two cargo missions by 2022

SpaceX hopes to land at least two cargo missions to Mars a mere five years from now. The aerospace company's chief, Elon Musk, discussed its plans at the International Astronautical Congress (IAC) in Australia. He talked about how SpaceX intends to use the BFR*, the massive rocket it's developing, to fly Martian settlers to their new home and to take people anywhere on Earth in under an hour. In addition to landing two cargo missions on the red planet by 2022, it hopes to be able to confirm sources of water and potential hazards by that time. SpaceX also plans to start building mining, power and life support infrastructure that year to prepare for the first settlers that could arrive as soon as 2024.

Musk said SpaceX aims to take the first settlers aboard two crewed flights to the red planet by 2024. Their supplies will be loaded onto two separate cargo flights also slated to land within that year. The first wave of settlers will have to set up the base to prepare for future waves who will work on expanding it further and terraforming their new home.

These are, however, very ambitious goals -- we could probably expect delays as SpaceX develops the technologies needed to make them happen. WN

* *BFR - yes, it stands for Big F---ing Rocket!* www.space.com/38393-spacex-bfr-mars-colony-rocket-name.html

Now more than ever, to stay competitive with the growing market, airlines are taking strides to operate more efficiently by tackling the challenges of our time through strategic changes and innovation. As a highly influential market, the aerospace industry serves as a leader in implementing these new cutting-edge technologies.

Rising expectations for next-generation aircraft, coupled with cost-reductive strategies, have pushed for means to fly lighter, faster, farther, safer, cheaper, and greener. These demands directly reflects onto the aerospace supplier's ability to make the impossible possible and keep pace with increased production rates by; one, taking advantage of the latest tools and

Machining Titanium for the Aerospace Industry

The aerospace industry has shown levels of consistent growth throughout the past decade, more than doubling its profits from $369 billion(U.S.) in 2004 - to over $746 billion (U.S.) in 2014[1]. Moreover, passenger demand is expected to rise 5 percent each year over the next 20 years, with estimates calling for roughly 1,420 new large commercial aircraft in 2016, and a total projected 35,318 new aircraft (excluding regional jets) over the next two decades[3].

COMPILED BY | MINX AVRABOS

methods, and two, efficiently choosing the right machines to adopt new processes into production successfully.

The aerospace industry's success has in part been possible due to the implementation of lighter materials like composites and laminated skins of both composite and titanium. Through the use of these materials, aerospace suppliers can reduce the overall weight of an aircraft without sacrificing its strength and structural integrity.

In the past, the most common materials found in aerospace manufacturing were aluminum alloys. Nowadays, machining advancements for titanium have made the once exotic and rarely-used metal, one of the most sought after and fastest growing materials to hit the market. So much so, that the airline industry serves as the leading consumer of titanium alloy products - making the two economically linked[4]. In previous applications, titanium was primarily found in aircraft engine sections. Now, titanium is used as a replacement for aerospace mechanisms such as fastening elements, airframes, and landing gear components[4].

One of titanium's most coveted characteristics, making it an ideal material for aircraft parts, is its high strength-to-weight ratio. This is particularly important when recognising that jet fuel serves as one of the most crucial factors in controlling airline costs and can attribute up to 40-55% of an aircraft's overall operational expenses[5]. In sum, a lighter aircraft inherently requires less fuel consumption, which calls for fewer refueling stops thereby allowing more air time and cutting costs.

Titanium is a Heat-Resistant Super-Alloy (HRSA), meaning that it has excellent mechanical strength, excellent surface

Titanium for Aerospace

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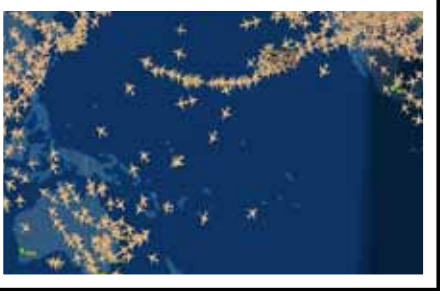
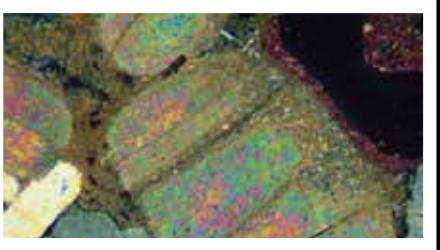
DID YOU KNOW?



More than 2,000 airlines provide service to nearly 4,000 airports, 28 million scheduled flights, and 2 billion passengers[1]!

There are approximately 1.5 million people in flight at any one time even though only 5 percent of the world's population has been on an airplane[6].



Titanium was initially called Gregorite in honour of its discoverer, British chemist, Reverend William Gregor, who stumbled across black, metallic sand in a creek bed in 1791. So where does the name "Titanium" originate? It's thanks to German chemist M.H. Klaproth, who renamed the metal after the Titans of Greek mythology[8].

stability, opposes corrosion/oxidation, and shows resistance to creep (movement/deformation) under high temperatures.

In addition to these characteristics, titanium has a plethora of other attractive features including an extremely high strength-to-density ratio (offering 60% of the density of steel), non-magnetic characteristics, resistance, a short radioactive half-life, and a low thermal expansion co-efficient[7].

Despite titanium being light-weight, its strength offers 80,000 psi for pure titanium and 180,000 psi-plus for its alloys[9]. Also, when compared to its steel counterparts, titanium alloys boast twice the elasticity, making them the preferred choice for parts that need the flexibility to resist fracturing under extreme pressures.

Some argue that amongst these attributes, the most vital is titanium's thermal stability. This elemental feature allows titanium to withstand extremely hot and cold temperature ranges, which unlike steel, could shatter in the same conditions. This is especially beneficial for aircraft environments, where jet engines and airframe parts endure full temperatures ranges of -57 °C to over 600 °C[4]. In fact, titanium's high melting point can reach upwards of 1725 °C, which is approximately 220 °C above the melting point of steel, and 1100 °C above that of aluminum[19].

All of the titanium's characteristics differ based on the type utilized:

- Unalloyed/Untreated Titanium – Qualities include excellent corrosion resistant, but lower strength properties.
- Alpha Structure (α alloy) – Provides excellent creep resistance and low/medium strength.
- Beta Structure (β alloy) – Offers high strength and high density and is most commonly found in high strength applications due to its forge-ability. Beta alloys are the most difficult to machine.
- Alpha Beta Structure (α-β alloy) – Offers medium/high strength and includes alpha and beta stabilizer elements.
  It is the most popular group in the aerospace industry[7].

In addition to previously mentioned qualities, titanium also offers superior resistance in extremely corrosive environments. This is thanks to a layer of protective, very stable, and highly adherent surface oxide film that forms when the metal, which is highly reactive to oxygen, is exposed to air or moisture. In fact, if titanium is scratched, the material's affinity for oxygen causes the protective oxide layer to refresh itself when exposed to air[15]. Also, due to the resistance to corrosion, parts made from the metal can be designed to have thinner walls. These critical and invaluable elements are what place titanium at the forefront of a variety of industries outside of aerospace, particularly automotive and medical.

With new intricate applications entering the market daily, suppliers are always looking for ways to fill orders most cost-effectively and productively possible to stay competitive in the industry. Since titanium has a particular window of successful machining parameters, to process the material (and do so rapidly) suppliers need the right machines combined with the proper tools and know-how. Otherwise, taking advantage of the uniquely challenging alloy can prove costly – turning the entire process into a manufacturing nightmare.

The same physical, chemical and mechanical properties that make titanium so desirable also make the material incredibly tricky to machine. In an industry where workpieces are costly, and production is time-consuming, taking necessary measures to understand the challenges of HRSAs allows suppliers to ensure that proper countermeasures are implemented - creating a thriving machining environment.

One of titanium's many challenges is poor thermal conductivity which makes it difficult for the heat that's generated during machining to dissipate from tool edges. This causes heat to adhere to the tool instead of the chip - a chief proponent of wear. Chemical reactions between titanium, the cutting tool, and its coating, can also cause a breakdown at the cutting edge due to similarities in properties. In addition to these issues, titanium's elasticity causes parts to push away from the cutting edge and rub against the flank of the tool, thereby increasing the friction and heat during the manufacturing process[12].

Using special tools and cutter paths can help minimize some of these issues. By using "chip thinning" methods - light depths of cut either axially or radially - and elevated feed-rates, manufacturers can improve overall cycle times, and when correctly applied, these countermeasures can reduce tool wear, most commonly being flank wear and notching[18].

In addition to improving tool life when machining titanium is the concern of achieving effective and fast chip removal rates - especially when machining at high speeds. If chips fall back into the machining interface, it can result in damaging the tool or work-piece, or in some cases, re-cutting of chips and machine tool failure. To avoid this issue, machines need to utilize a combination of high-pressure coolant pumped through the spindle, the tool, and coolant nozzles, with a shower curtain in place. These features work collectively to cool the product by flushing chips away quickly and efficiently. Also, additives in today's coolants provide an added lubricity that's vital to minimizing friction and damage to the component[11].

Above all, the most complicated issue attributed to machining titanium is its high work hardening ability. Work hardening makes machining this material incredibly tricky and in some extreme cases, causes surface or internal damage to the metal - rendering it scrap[12].

These are just some of the concerns that make titanium's narrow band of machinability unforgiving to improper cutting techniques. wn

REFERENCES

1 Gaille, Brandon. "39 Eye Opening Airline Industry Trends". http://brandongaille.com/39-eye-opening-airline-industry-trends/. 13 April 2015.

2 Henwood, Stephanie – Morgan Technical Ceramics. "Up, up and away – Aerospace Industry Performance and Future Growth". http://www.morgantechnicalceramics.com/blog/and-away-aerospace-industry-performance-and-future-growth.

3 Deloitte. "2016 Global aerospace and defense sector outlook". https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Manufacturing/gx-manufacturing-2016-global-ad-sector-outlook.pdf. January 2016.

DID YOU KNOW?

Since the 1950's, titanium has been widely used in the medical field for ball screws, hip/knee joints, spinal fusion cages, bone plates, and more recently, in artificial hearts! More incredibly - titanium's durability can make these medical applications last for more than 20 years! This is all possible due to titanium's non-toxic state, ability to fight corrosion from bodily fluids, and its compatibility with bone density[10].

Even though titanium is Earth's fourth most abundant metallic element (making up about 62% of the crust!) purchasing the material is expensive because it must be cast under an inert atmosphere. During excavation, titanium is rarely found in its pure form. Instead, it typically exists within minerals such as anatase, brookite, ilmenite, leucoxene, perovskite, rutile, and sphene[13].

Titanium for Aerospace

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DID YOU KNOW?

Magnesium or sodium are mixed with the titanium chloride in argon gas. Once applied to temperatures of 1,200 °C, the magnesium or sodium reduces the titanium chloride to pure titanium. This overall process is about 10,000 times less efficient as the process utilized when making iron, which attributes to titanium's overall expensive cost[16]. To produce pure titanium, manufacturers use the Kroll process which first treats titanium oxide ore with chlorine, creating titanium chloride.

Although titanium plays a prevalent role in the aerospace industry, its most common use is as titanium dioxide, a white pigment used in paints and sunscreen due to its ability to refract light and absorb ultraviolet rays[16].

4 TMS Titanium. "Titanium and the Aerospace Industry". https://tmstitanium.com/titanium-and-the-aerospace-industry/. 28 June 2013.

5 Clayton, Edward. Hilz, Andreas. "2015 Aviation Trends". http://www.strategyand.pwc.com/perspectives/2015-aviation-trends.

6 CIT Group Inc. "Fun Facts About the Aerospace Industry". https://www.cit.com/thought-leadership/aerospace-aviation-facts/.19 August 2014.

7 Sandvik Coromant. "Titanium Alloys". http://www2.coromant.sandvik.com/coromant/pdf/aerospace/gas_turbines/C_2920_18_ENG_043_074.pdf.

8 Supra Alloys. "History of Titanium". http://www.supraalloys.com/history.php. 2016.

9 Gurstelle, William. "Building Bots: Designing and Building Warrior Robots". Chicago Review Press, 2002.

10 Titanium Industries. "Medical – Othopedic". http://titanium.com/markets/medical/orthopedic/.

11 Sandvik Coromant. "Troublesome Titanium – Tips on Machining is Tough Material". http://www.sandvik.coromant.com/us/News/technical_articles/Pages/Troublesome-Titanium-Tips-on-machining.aspx. 14 August 2014.

12 Kennametal. "Titanium Machining". https://www.kennametal.com/content/dam/kennametal/kennametal/common/Resources/Catalogs-Literature/Industry%20Solutions/Titanium_material_machining_guide_Aerospace.pdf.

13 How Products Are Made. "Titanium". http://www.madehow.com/Volume-7/Titanium.html.

14 Richt, Christer. "Turning Titanium – Developments in Application Technology". http://www2.coromant.sandvik.com/coromant/pdf/Aerospace/tekn_art_titan.pdf. 2003.

15 Titanium Industries. "What is Titanium". http://titanium.com/technical-data/what-is-titanium/.

16 Pappas, Stephanie. "Facts About Titanium". http://www.livescience.com/29103-titanium.html. 22 October 2014.

17 Sandvik Coromant. "Heat Resistant Super Alloys From Sandvik Coromant". http://www.ferret.com.au/c/sandvik-coromant/heat-resistant-super-alloys-from-sandvik-coromant-n668860. 29 January 2007.

18 Sandvik Coromant. "Wear on Cutting Edges". http://www.sandvik.coromant.com/en-gb/knowledge/materials/cutting_tool_materials/wear_on_cutting_edges.

19 Total Materia. "Physical Properties of Titanium and its Alloys". http://www.totalmateria.com/Article122.htm. May 2005.

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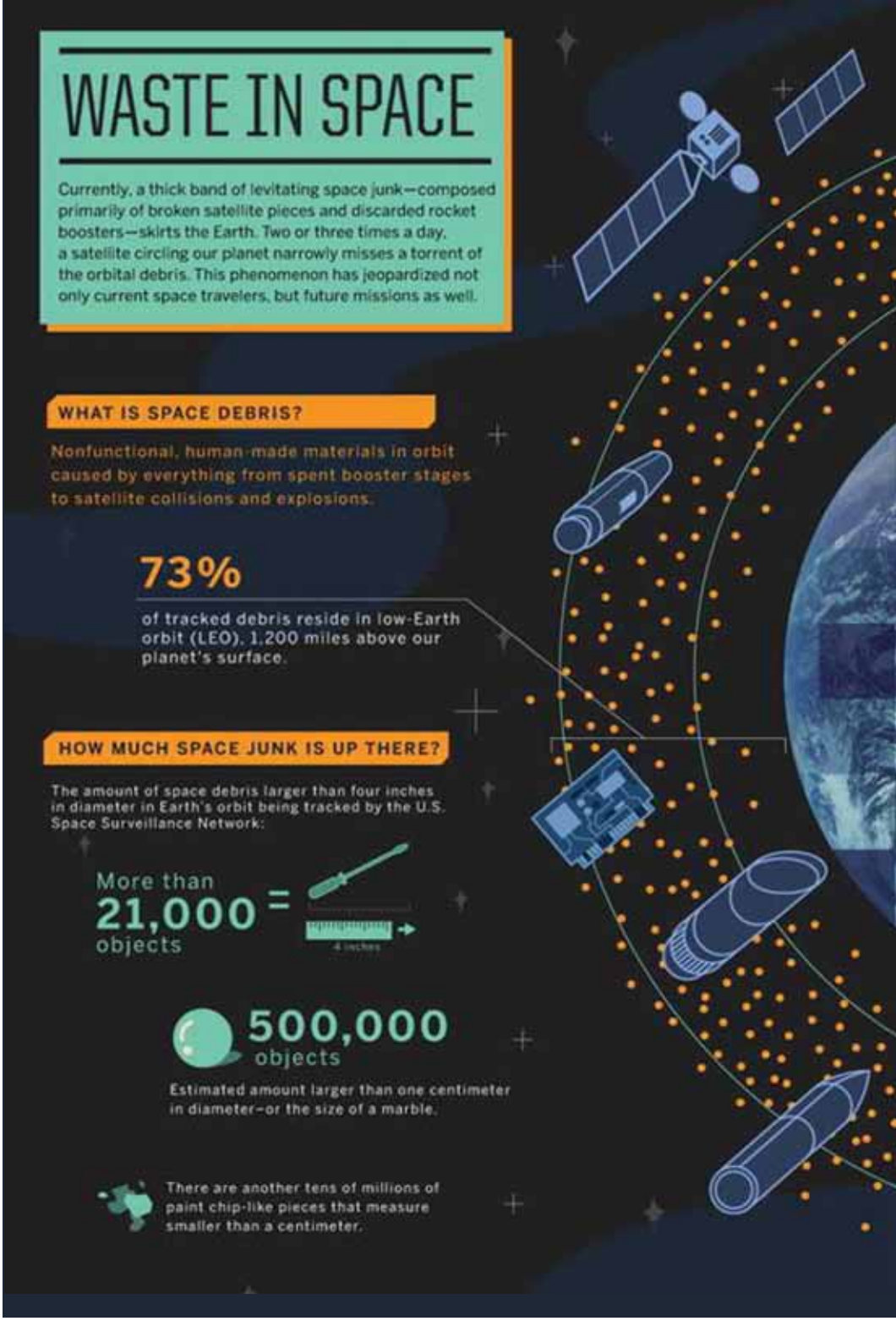
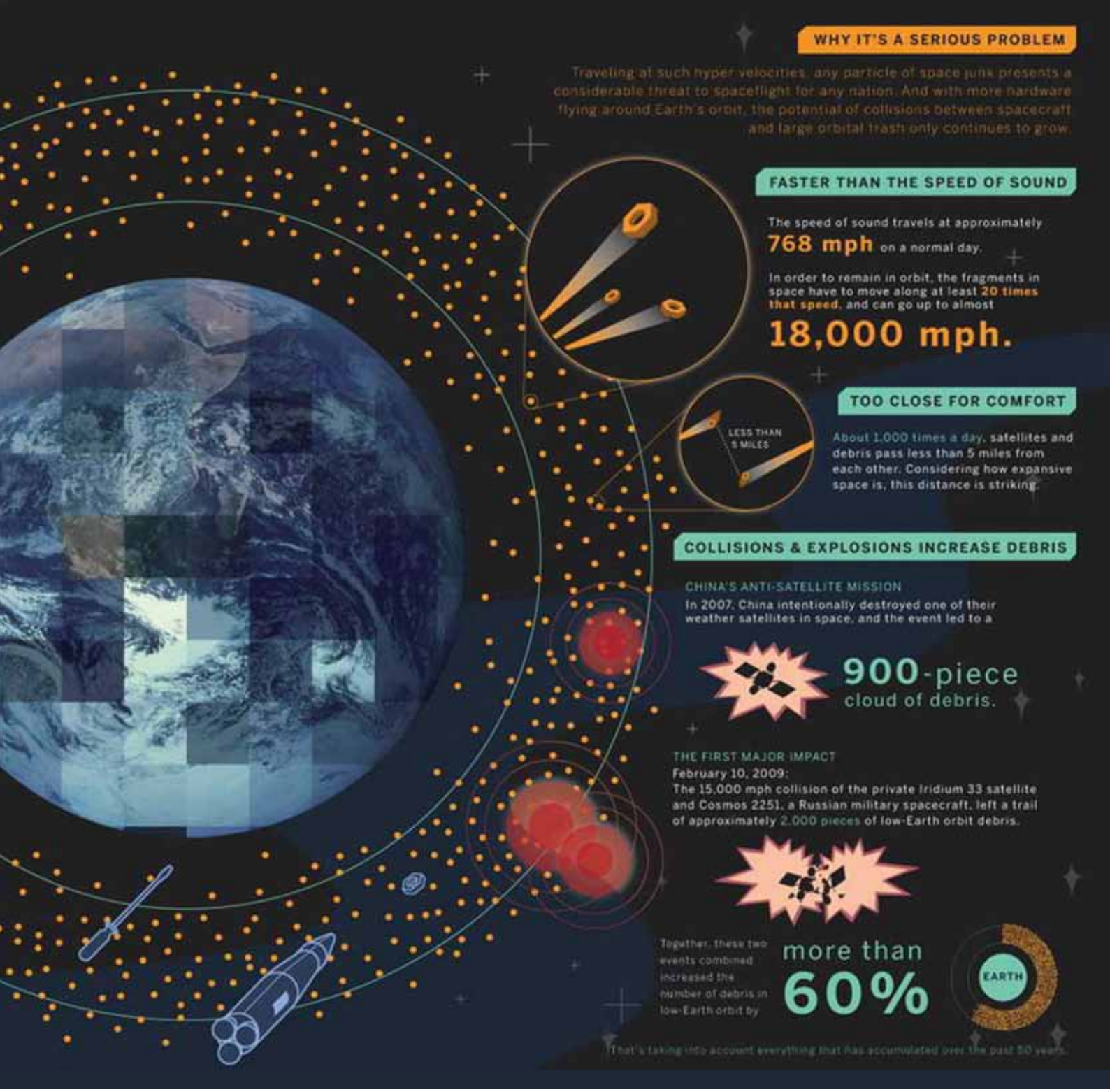


The space-race is on - but with a different flair. The amount of junk in space is surmountable, and if the homo sapiens do not do anything about clearing it up, the earth will become a junk-yard! In this article, we take a look at who will win the junk removal race - the US or Europe?

Space Junk and the experiments

BY | MINX AVRABOS



The first experiment designed to demonstrate effective space-debris removal in orbit has just reached the International Space Station aboard SpaceX's Dragon capsule.

A SpaceX Dragon cargo capsule carrying nearly 3 tons of supplies and science gear has arrived at the International Space Station (ISS) after a two-day orbital chase.

Astronauts aboard the ISS snagged the uncrewed Dragon using the orbiting lab's strong Canadarm2 robotic arm. The cargo vehicle had launched Monday afternoon (April 2) aboard a SpaceX Falcon 9 rocket, on a contracted mission for NASA.

That liftoff initiated the second mission for both the rocket's first stage and the Dragon. The booster helped launch another SpaceX cargo mission in August 2017, and this same capsule previously visited the ISS in April 2016.

Such re-use is part of SpaceX's plan to slash the cost of spaceflight, thereby opening the heavens to exploration.

Space Junk

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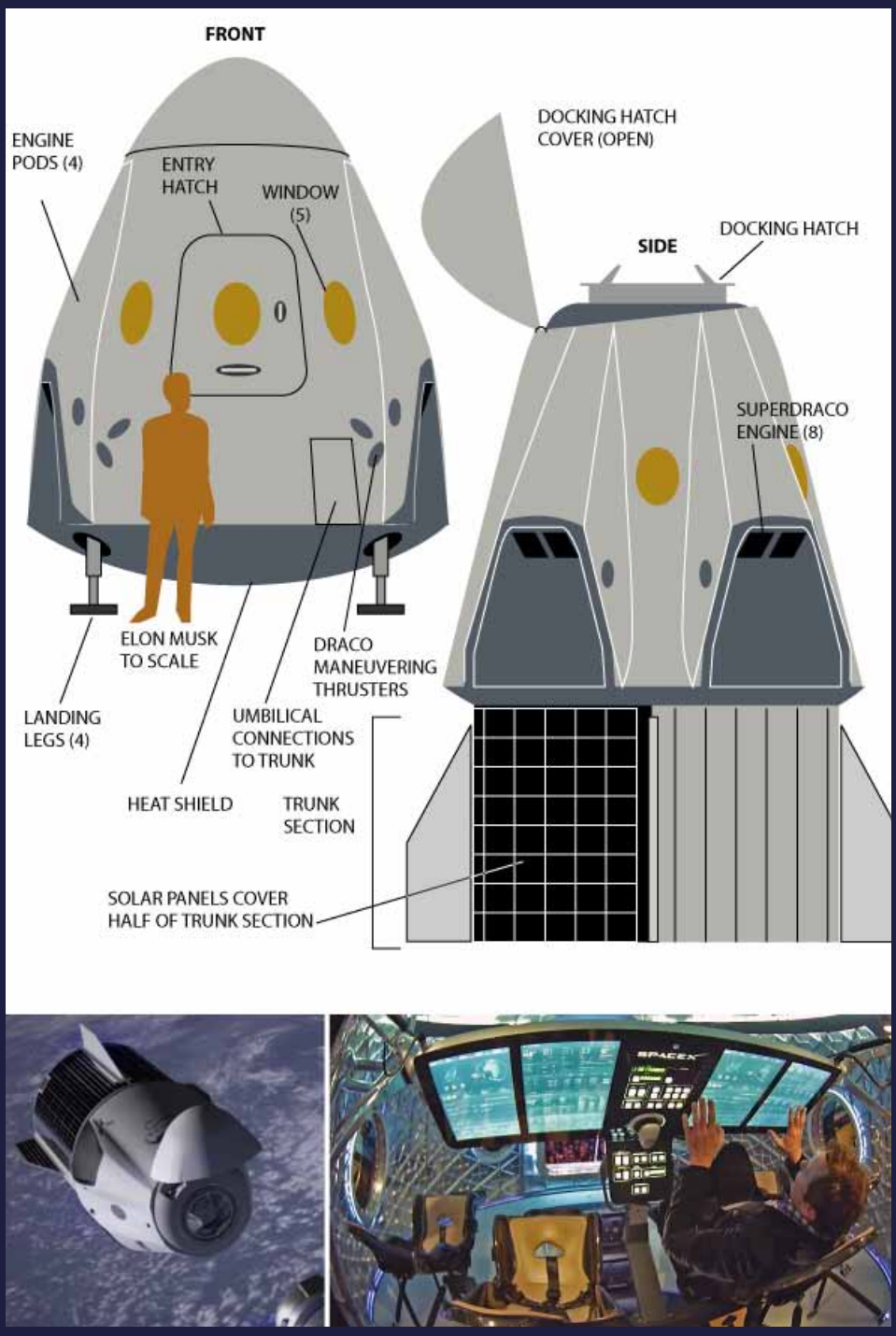
HOW THE SPACEX DRAGON CAPSULE WORKS



Left: Dragon V2 opens its nosecone to dock with ISS.
Right: Elon Musk in the pilot seat of a Dragon Mockup capsule. A steering joystick and physical buttons for critical functions occupy the center section of the control panel.

Revealed on May 29, 2014, SpaceX's Dragon version 2 capsule can carry a crew of seven astronauts to the International Space Station.

The re-usable Dragon is expected to last for up to 10 flights before needing significant refurbishment. The capsule lands on the ground using its 7.5 ton thrust SuperDraco rocket engines and landing legs, with parachutes also on board as a backup.

Simulation of Dragon Landing using its Superdraco rocket engines.

SpaceX's Dragon space capsule design is a gumdrop-shaped spacecraft built for spaceflights into and from low-Earth orbit. The shuttle was initially designed as an unmanned spacecraft but is being scaled up to launch astronauts into space as well.

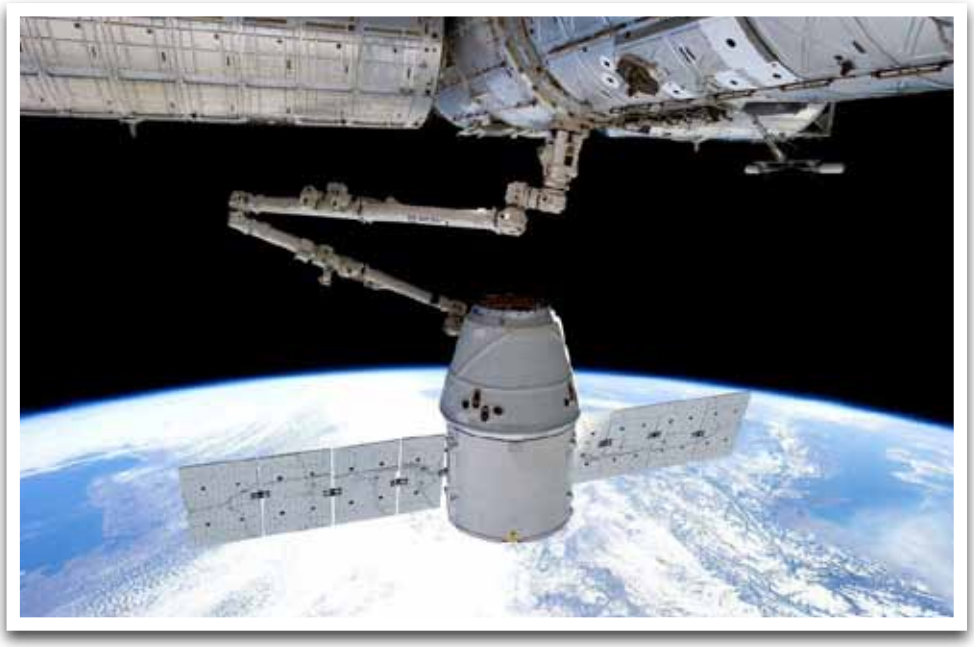
The Dragon space capsule is 4.4 meters high and 9.2 meters wide. It launches on SpaceX's Falcon 9 rocket, a two-stage booster that currently starts from a pad at Cape Canaveral Air Force Station in Florida.

The Dragon is a solar-powered spacecraft with about 7 meters^3 of usable space inside its pressurized vessel. The probe also has an unpressurized "trunk" that offers an additional 14 meters^3 of space for cargo. Altogether, the spacecraft can carry up to 3,310 kilograms of supplies into orbit.

The Dragon will remain at the ISS until next month when crewmembers will load it up with about 1,800 kg of cargo from the station, SpaceX representatives have said. The capsule will depart and maneuver its way to a splashdown in the Pacific Ocean off Baja California, where SpaceX personnel will retrieve it by boat.

There was no recovery for the Falcon 9 that launched the capsule, however; SpaceX did not attempt to land the first stage, because that Falcon 9 version wasn't designed to fly more than twice. The next-generation Falcon 9, known as the Block 5, will be able to launch and land at least ten times, according to SpaceX representatives.

Dragon freighters aren't likely to see such massive reuse, at least not in the near future.



Astronauts aboard the ISS snagged the uncrewed Dragon (April 4) at 6:40 a.m. EDT (1040 GMT) using the orbiting lab's strong Canadarm2 robotic arm.

"For the Dragon 1 cargo vehicle, we are certifying it to be capable of three full flights," Jessica Jensen, SpaceX's Dragon Mission Manager, said in a post-launch news conference. *"So, some of the Dragons are already seeing two; it will be capable of a third flight."*

REMOVE DEBRIS EXPERIMENT - UK

The RemoveDebris experiment, designed by a team led by the University of Surrey in the U.K. as part of a R225 million, European Union (EU)-funded project, is about the size of a washing machine and weighs 100 kilograms.

It carries three types of technologies for space-debris capture and active deorbiting — a harpoon, a net and a drag sail. It will also test a lidar system for optical navigation that will help future chaser spacecraft better aim at their targets.

"For this mission, we are ejecting our little CubeSats," Jason Forshaw, RemoveDebris Project Manager at the University of Surrey, said last year. *"These little CubeSats are maybe the size of a shoebox, very small. We eject them and capture them with the net."*

He said the team decided to carry up their pieces of space junk, due to legal issues that don't allow the manipulation of space objects that belong to someone else, even if the objects are no longer functional.

The main spacecraft will be launched later this year from the International Space Station using the commercial CubeSat deployer operated by Houston, Texas-based NanoRacks. Once the probe reaches a safe distance from the space station, it will eject the two CubeSats. After that, the chaser spacecraft will deploy the net, aiming to capture the CubeSats.

Space Junk

continues from page 31

Forshaw said that for this experiment, the chaser spacecraft wouldn't be connected to the net with a leash, as it would be in a real mission.

"There are a lot of problems that could occur with a tether," he said. *"For example, the CubeSat could bounce back and hit your main satellite."*

The space junk harpoon, built by Airbus Defence and Space in the U.K., will be later fired into a fixed target that will extend from the primary satellite on a boom.

After it completes the harpoon, net and lidar experiments, the RemoveDebris spacecraft will deploy the drag sail that will speed up its deorbiting process.

"We are testing these four technologies in this demonstration mission, and we want to see whether it works or not," said Forshaw, referring to the harpoon, net, drag sail, and lidar. *"If it works, then that would be fantastic, and then these technologies can be used on future missions."*

The project is part of the European Space Agency's (ESA) Clean Space initiative, which, in the mid-2020s, aims to carry out an ambitious mission that will remove the defunct Envisat, the most effective Earth-observation satellite ever built.

The harpoon is one of the technologies ESA is considering for tackling Envisat, an 8.8-ton monster that died in 2012 after ten years of service. Envisat is now one of the most significant pieces of space junk threatening spacecraft in Low Earth Orbit (LEO), experts say.

"The harpoon needs to be about a meter and a half long and weigh 2.5 kilograms, to capture the Envisat," Wayman said. *"In comparison to Envisat, it's pretty small."*

The space-junk harpoon tested by Airbus in a lab here on Earth on March 15, 2018.

The chaser spacecraft carrying the harpoon would attach itself to its target and then use its thrusters to drag Envisat into Earth's atmosphere for a controlled re-entry.

ESA's Luisa Innocenti, who leads the Clean Space program, said the agency is currently more inclined to use a robotic arm because this technology can be used for in-orbit servicing.

However, Wayman said that commercial opportunities for the harpoon technology would likely be plentiful even if it isn't used to de-orbit Envisat.

"We are designing the harpoon around Envisat because it's the largest piece of debris," Wayman said. *"If you can capture Envisat, you can capture everything. Active space-debris removal is getting more and more important. Every year that we don't achieve the target of deorbiting five large pieces of space debris, the situation gets worse, and we are more likely to have more collisions."*

The world's space agencies agree that five large defunct satellites need to be removed from LEO every year to help prevent the Kessler syndrome, the unstoppable cascade of orbital collisions predicted by NASA scientist Donald Kessler in the late 1970s.

Wayman and his colleagues also designed and built a smaller harpoon system for the RemoveDEBRIS mission, an active debris-removal demonstration to be launched next month. As part of the mission, the harpoon will fire into a fixed target extended from the main spacecraft on a boom. Wayman said the harpoon test is expected to take place in late 2018 or early 2019. wn

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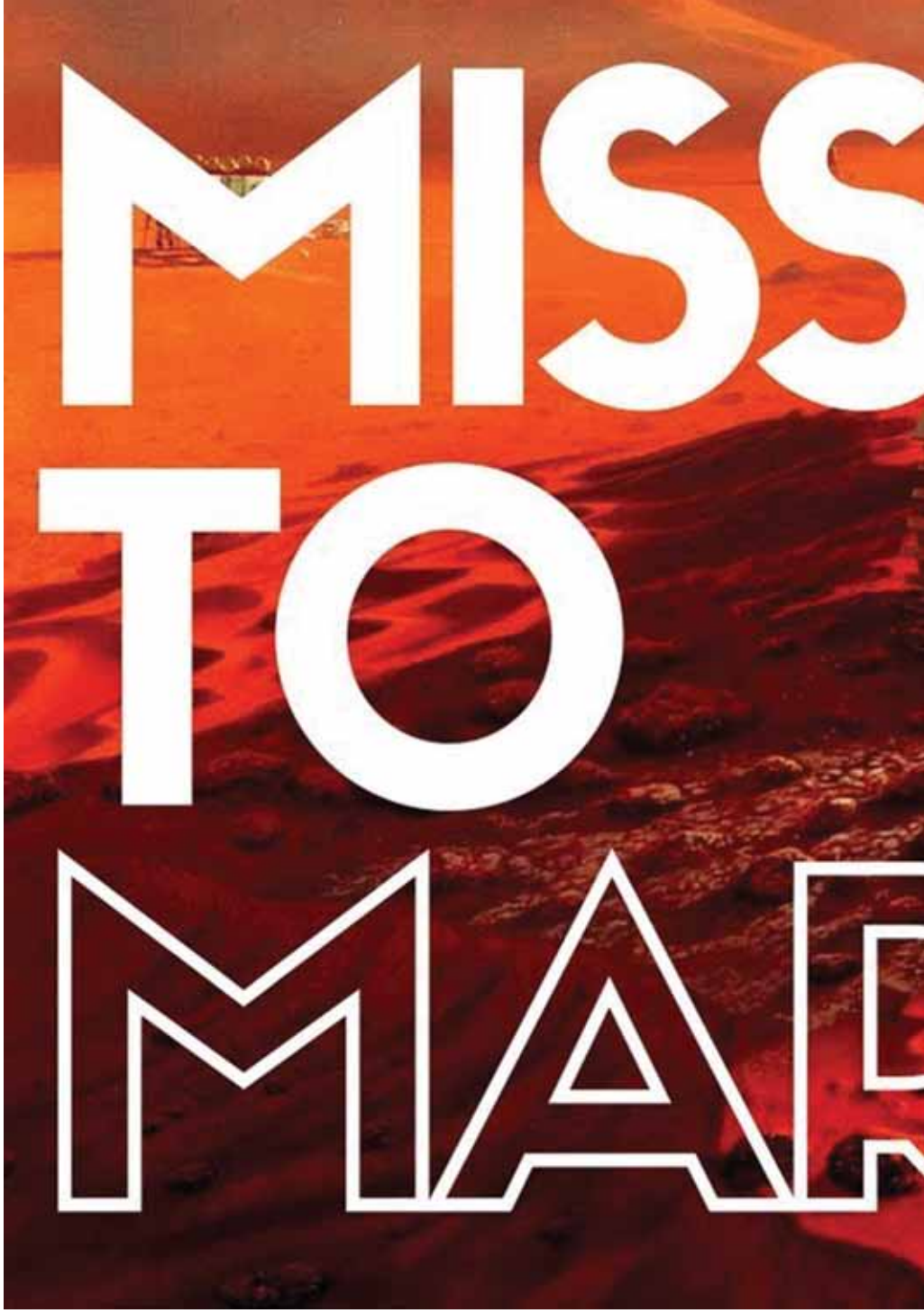

Mars One aims to establish a permanent human settlement on Mars. Several unmanned missions will be completed, forming a comfortable environment for carefully selected and trained crews who will depart for Mars.

Funding and implementing this plan will not be easy; it will be hard. The Mars One team, with its advisers and with established aerospace companies, will evaluate and mitigate risks and identify and overcome difficulties step by step. Mars One is a global initiative whose goal is to make this everyone's mission to Mars, including yours.

PERMANENT SETTLEMENT

Sending humans to Mars is a phenomenal undertaking by all standards and presents genuine risks and challenges. Establishing a permanent settlement is very complicated, but it is far less complicated and requires much less infrastructure sent to Mars than return missions.

Mars One has already started contracting established aerospace companies that will be able to develop the necessary systems. All systems require design, construction, and testing, but no scientific breakthroughs are needed to send humans to Mars and to sustain life there.

A habitable settlement will await the

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CATECHISM

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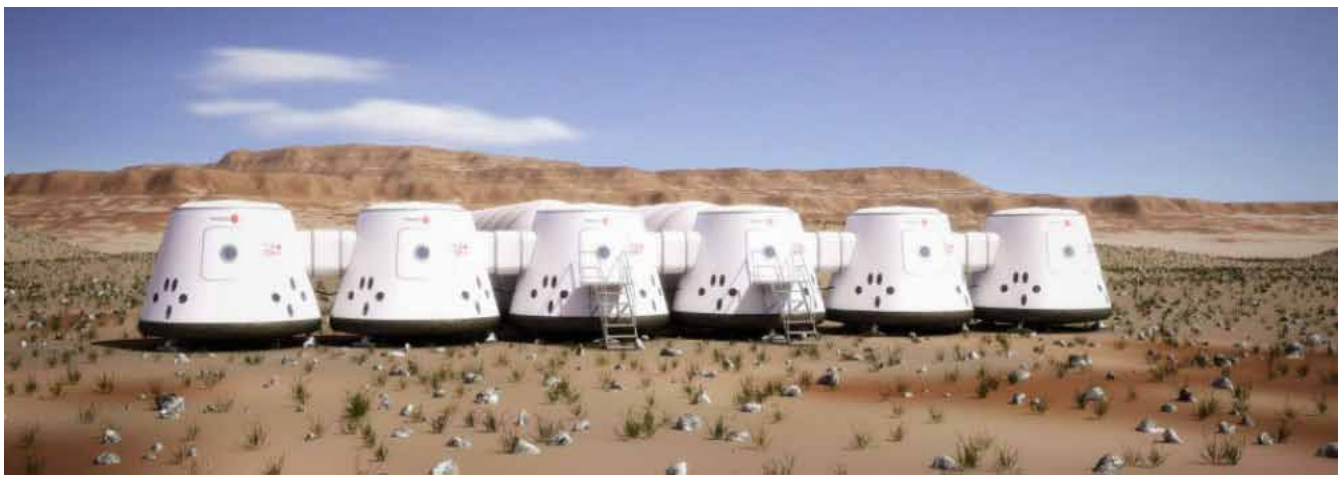

Mission to Mars

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first crew before they depart Earth. The hardware needed will be sent to Mars in the years ahead of the humans.

ROADMAP

2011 - MARS ONE FOUNDED

In 2011, Bas Lansdorp and Arno Wielders laid the foundation to begin the Mars One mission plan. The first step included holding discussion meetings with potential aerospace component suppliers in the United States, Canada, Italy, and the United Kingdom. They set the mission architecture, budgets, and timelines after receiving feedback from the supplier engineers and business developers. It resulted in a baseline design for an achievable mission of permanent human settlement on Mars with existing technology.

2013 - START CREW SELECTION

In April 2013, the Astronaut Selection Program (ASP) was launched at press conferences in New York and Shanghai. The selection program required an online application and proceeded with video applications and personal interviews. The subsequent selection rounds consist of group challenges and simulations.

At the program's end, six teams of four individuals will be chosen for training. New ASPs will begin every year to replenish the training pool regularly. Also, during this time an analog of the Mars habitat is to be constructed on Earth for technology testing and training purposes.

ASTRONAUT SELECTION AND PREPARATION (ASP)

A global search was conducted for the first humans to set foot on Mars and make it their home. In an extensive training period, candidates will learn the skills they will need on Mars and their journey there. The combined skill set of each astronaut team member will cover an extensive range of disciplines.

In 1000 years, everyone on Earth will still remember who the first humans on Mars were!

2017 - START OF CREW TRAINING

The first teams of candidates were selected and started training in 2017. They are preparing together for the launch in 2031. The group's ability to deal with prolonged periods of time while sequestered in a remote location will be the most crucial part of their training. Thus, they will learn how to repair components of the habitat and rover, train in medical procedures, and learn to grow food in the habitat.

Every group spends several months of each training year in the analog outpost to prepare for its mission to Mars. The first outpost simulation location, a Mars-like terrain that is relatively easy to reach, will be chosen. A second training outpost will be located at a more remote environment like the Arctic desert.

2022 - DEMO MISSION

A demonstration mission to Mars will be launched to provide proof of the concept for some of the technologies that are crucial for Mars One's human mission. Beyond launch and landing on Mars, the mission will prove several essential technologies for Mars One's human mission. The lander payload will include:

- a camera for video streaming from Mars;
- a water experiment to confirm that it can be extracted from the Martian soil, one of the most critically important aspects of human life on Mars;
- multiple solar panel brands and types of thin-film solar panels for experimenting for their suitability in providing enough renewable energy to maintain and grow the settlement; and
- a payload selected from the entries of universities worldwide.

2024 - COMSAT MISSION

A communications satellite will be launched to Mars where it will be placed into the Mars orbit. This satellite will enable communications between Earth and Mars and relay images, videos, and other data from the Mars surface on a 24/7 basis, except when the sun is between the two planets.

COMMUNICATION SYSTEM

The communications system consists of a satellite in orbit around Mars, over the Mars One settlement, one in orbit around the sun, and ground stations on Earth.

The satellite over the Mars settlement is an areostationary satellite, the Mars equivalent of a geostationary satellite. It is always in the same place in the sky on Mars, receiving data from the settlement and transmitting it to Earth. On Earth, the data is received by ground stations using giant satellite dishes. The areostationary satellite enables almost 24/7 communication, which is only interrupted when Mars is in between the satellite and the Earth.

This is solved by placing the second satellite in orbit around the sun. It will follow the same orbit as the Earth does but trails 60 degrees behind it in the L5 Lagrangian point of the Sun-Earth system. With this second satellite in place, when Mars is in between the areostationary satellite and the Earth, the signal can be relayed by the second satellite.

Mars Rover

Once every 26 months, the Sun is precisely in between Mars and the Earth. This occultation lasts about six weeks. The second communications satellite will also be used to relay signals during this period.

However, when the Sun is in between Mars and the Earth and at the same time Mars is in between the areosynchronous satellite and the second satellite, we will have no contact with Mars for about two hours. Fortunately, this is a rare situation and occurs when it is after midnight on Mars.

2026 - ROVER & COMSAT MISSION

A rover and a trailer will be sent to Mars. The rover will use the trailer to transport the landing modules to the outpost location. It will drive around the region to find the best site for the settlement and will prepare that area for the arrival of the cargo missions.

MARS ONE ROVER

The Rover for the Mars One mission is not a scientific Rover. It is a capable and powerful tool, with a robotic hand to carry out a wide variety of tasks. The Rover is accompanied by a trailer, which is used to transport landing modules and for power generation.

In contrast to the scientific rovers dispatched to Mars to date, the Mars One Rovers' tasks will be focused more on utility, the deployment and maintenance of the human Settlement on Mars, which will include:

- Autonomous travel to locate the most suitable location for settlement.
- Measure the amount of water in the soil.
- Move the Landers to the preferred locations on the trailer.
- Remove protective panels from the Landers.
- Unroll and lay down the thin film solar panels.
- Extract (from the Lander) and assist with inflation of the Living Unit.
- Connect the air tube between the Life Support Unit and the Living Unit.
- Deposit soil in the Support Unit for water extraction and remove the dry soil.

A second communications satellite will be launched into orbit around the Sun. The two communications satellites together will enable 24/7 communication with Mars, even when the Sun is between the two planets.

2029 - CARGO MISSIONS

Six cargo missions will be launched to Mars, containing a second rover, two living units, two life support units, and a supply unit. The six cargo units will land up to 10 km away from the outpost on Mars, using a rover signal as a beacon.

2030 - OUTPOST OPERATIONAL

The rover will pick up all cargo units using a trailer, starting with the first life support unit. The rover will place it in the correct location and deploy the thin-film solar panels to power the life support unit. The rover will then be able to connect to the life support unit to recharge its batteries much faster than using only its panels, allowing it to work more efficiently.

The rover will pick up all other cargo units and deploy the thin-film solar panel of the second life support unit and the inflatable sections of both living units.

The life support unit will be connected to the living units by a hose that can transport water, air, and electricity. Once these are combined, the Environmental Control and Life Support System (ECLSS) will be activated. The rover will feed Martian soil into the ECLSS, and the water will be extracted from this soil by evaporating its subsurface ice particles in an oven.

The evaporated water is condensed back to its liquid state and stored, and part of the water is used for producing oxygen. The nitrogen and argon filtered from the Martian atmosphere will make up the other components of the breathable air inside the habitat.

Before the first crew begins its journey, the ECLSS will have produced a breathable atmosphere of 0.7 barometric pressure, 3,000 liters of water, and 240 kg of oxygen which will be stored for later use.

Mission to Mars

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Mars lander

LIFE SUPPORT UNITS

The Life Support Unit is a Lander rigged with unique technologies which capitalize on the natural resources available on Mars: the Environmental Control and Life Support System (ECLSS).

This system uses these natural resources to create a habitable living environment for the astronauts, as follows:

- Electrical energy is generated through the application of thin-film solar photovoltaic panels. These are flexible and can be rolled up for compact transportation to Mars;

- Potable water will be created through the heating of water ice in the marsian soil. About 60 kilograms of soil is loaded into a container within the ECLSS by the Rover and heated to evaporate the water. The water is condensed, and the dry soil returned to its origin. A portion of the water is stored while a part is used to produce oxygen. Each ECLSS can collect 1500 liters of water and 365 kilograms of oxygen in 365 days time;

- Nitrogen and argon gas are extracted from the Mars atmosphere and injected into the habitable space as inert gases. Remember, 80% of what we breathe on Earth is nitrogen.

- The Life Support Unit is connected to the Living Unit by a tube which feeds the oxygen, nitrogen, and argon to create a comfortable atmosphere. Once the astronauts have landed, it will also be in charge of the water purification and removal of waste gas (carbon dioxide) from the Living Unit atmosphere.

- The rover will also deposit Martian soil on top of the inflatable sections of the habitat to shield it from radiation.

RADIATION PROTECTION

How much radiation will the settlers be exposed to?

Findings by an instrument aboard the Mars transit vehicle that carried the Curiosity rover show that radiation exposure for a mission of permanent settlement will be well within space agencies' astronaut career limits.

RADIATION ON THE WAY TO MARS

A study published in the journal Science in May 2013 calculates 662 +/ 108 millisieverts* (mSv) of radiation exposure for a 360-day return trip, as measured by the Radiation Assessment Detector (RAD). The study shows that ninety-five percent of the radiation received by the RAD instrument came from Galactic Cosmic Rays or GCRs, which are hard to shield against without use of prohibitive shielding mass.

During the 210-day journey, the Mars One settlers will be exposed to 386 +/-63 mSv of radiation, considering these recent measurements as standard. This exposure is below the limits of accepted standards for an astronaut career: European Space Agency, Russian Space Agency and Canadian Space Agency limit is 1000 mSv; NASA limits are between 600-1200 mSv, depending on sex and age.

MARS TRANSIT HABITAT RADIATION SHELTER

On the way to Mars, the crew will be protected from solar particles by the structure of the spacecraft. The team will

A millisievert (mSv) is defined as "the average accumulated background radiation dose to an individual for 1 year, exclusive of radon." 1 mSv is the dose produced by exposure to 1 milligray (mG) of radiation.

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Mission to Mars

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receive the general protection of 10-15 g/cm^2 shielding from the structure of the Mars transit vehicle. In case of a solar flare or Solar Particle Event (SPE), this shielding will not suffice, and the crew will retreat to a dedicated radiation shelter in the Mars Transit habitat, taking their cue from the onboard radiation monitoring and alert system.

The water tanks and other storage equipment will be used to create this dedicated radiation shelter that will also function as crew sleeping quarters.

The radiation shelter located in the empty water tank will provide additional shielding to the level of 40 g/cm^2. The astronauts should expect one SPE every two months on average and a total of three or four during their entire trip, with each one usually lasting not more than a couple of days.

RADIATION ON MARS

Mars's surface receives more radiation than the Earth's but still blocks a considerable amount. Radiation exposure on the surface is 30 μSv per hour during solar minimum; during solar maximum, dosage equivalent of this exposure is reduced by the factor two (2).

If the settlers spend on average three hours every three days outside the habitat, their exposure adds up to 11 mSv per year.

The Mars One habitat will cover several meters of soil, which provides reliable shielding even against galactic cosmic rays. Five meters of soil will give the same protection as the Earth's atmosphere - equivalent to 1,000 g/cm^2 of shielding.

With the help of a forecasting system, taking shelter in the habitat can prevent radiation exposure from SPEs.

2031- DEPARTURE CREW ONE

Ready for liftoff! The first crew will start their journey to Mars.

After receiving the green light on the status of all systems on Mars, the Mars Transit Vehicle (MTV) will be prepared for the trip to Mars. First, a transit habitat and a Mars lander, with an assembly crew aboard, will be launched into Earth orbit.

The assembly crew will dock the Mars lander to the transit habitat. About thirty days later, two propellant stages and the boosters that will "kick" the transit vehicle from low Earth orbit to Mars transfer orbit, will be launched and connected.

Once that is successfully completed, the first fully trained Mars crew will be launched into the same Earth orbit to switch places with the assembly crew, which will descend back to Earth. After a final check of all systems on Mars and on the transit vehicle, engines of the propellant stages will be fired, and the MTV will be launched into a Mars-transit trajectory. This is the point of no return for the Mars crew.

The cargo for the second crew will be launched toward Mars in the same month as the launch of the first Mars settlers.

2032 - LANDING CREW ONE

Approximately twenty-four hours before landing, the crew will move from the transit habitat into the landing module, bringing some of the supplies from the transit habitat. The landing module will then detach from the transit habitat, which is too large to land on Mars. The transit habitat is discarded and stays in orbit around the sun.

The landing technology will be the same as used for previous cargo missions. This will ensure that the human crew lands in a system that has been tested several times already. Upon landing, the team takes up to forty-eight hours to get used to gravity after spending six to eight months in space.

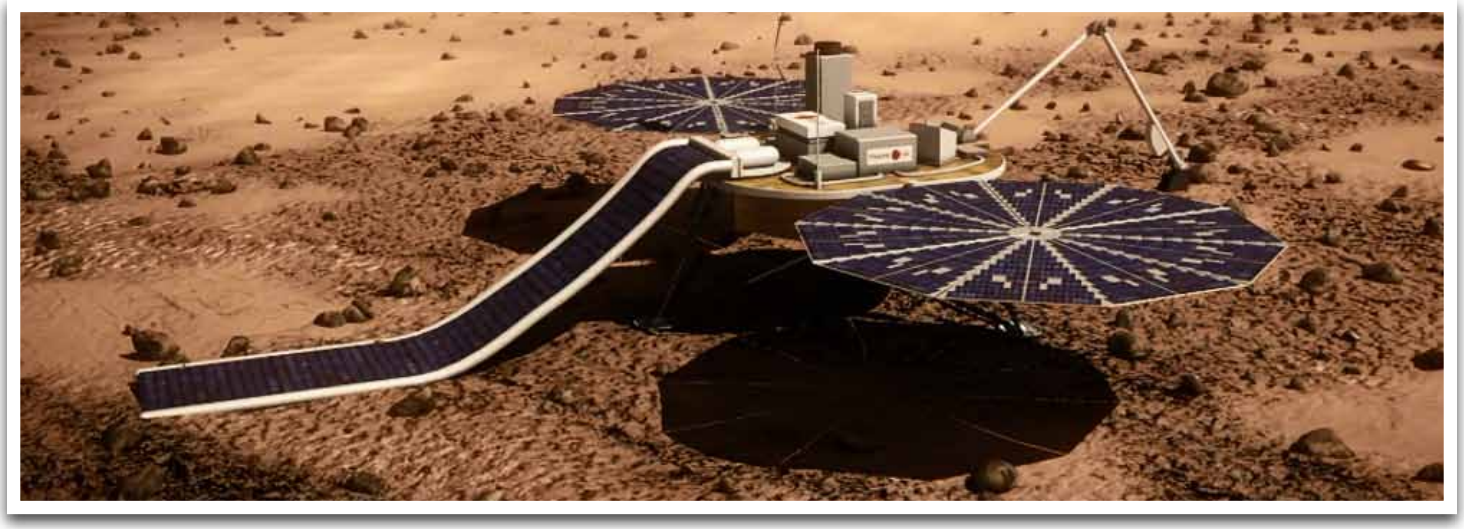
The astronauts will leave the lander in their Mars suits and will be picked up by the rover that will bring them to the outpost.

They will enter the settlement through an airlock and spend the next few days in one of the living units, recovering and settling into their new environment. After their acclimatization period, the crew will deploy the rest of the solar panels, install the hallways between the landers, and set up food production units.

Redundancy is critical because the astronauts can't abandon their mission in case of an emergency. When the first crew lands, it will find the established outpost with good redundancy as it will include two living units, each large enough to house the team of four, and two life support units that are each capable of providing enough water, power, and breathable air for the entire crew.

To add even more redundancy, the cargo for the second crew will land within a few weeks after the first crew has landed.

When the hardware for the second crew is incorporated, the team of four astronauts will have four living units and four life support units, enough to sustain a group of sixteen astronauts.



Mars Landing Module

2033 - DEPARTURE CREW 2

The second crew will depart from Earth, and the cargo modules for the third crew will be launched.

When the astronauts land on Mars, they will be welcomed by the first crew. Their living quarters will already be prepared. The hardware for the third crew will land a few weeks later and will be added to the settlement. This process will continue as additional crews and cargo modules land every 26 months.

THE TECHNOLOGY

Permanent settlement allows Mars One to use technology that is not substantially different from existing systems. The hardware needed explicitly for this mission still needs to be designed, built, and tested but the technology already exists. Mars One is not an aerospace company and will not create or manufacture mission hardware.

All equipment will be developed by third-party suppliers and integrated into their established facilities.

Mars One has visited significant aerospace companies around the world to discuss the requirements, budget, and timelines with their engineers and business developers. The feedback received in these meetings composed the current mission plan. Mars One will contract a supplier for improving the conceptual designs from the preliminary results. The first studies were awarded to a supplier.

The mission is comprised of the following primary hardware components.

MARS LANDING MODULE

Mars One will secure the landing modules from one of the experienced suppliers in the world, for example, Lockheed Martin. Similar landers will be equipped to perform different functions, like;

- carrying Life Support Units that generate energy, water and breathable air;
- moving Supply Unit with food, solar panels, spare parts and other components;
- carrying Living Units that are outfitted with deployable inflatable habitats;
- Carrying Humans to the surface of Mars; and
- Moving Rovers to the surface of Mars.

ROVERS

Two rovers will be sent to Mars to set up the outpost before the humans arrive. Mars One's rover supplier will determine the exact rover strategy; it is possible that instead of one large rover, multiple smaller rovers will be sent. For example, a first rover accompanied by a trailer system used for transporting the landing capsules.

MARS SUIT

All astronauts must wear their Mars suits when exposed to the Mars atmosphere. Like those used by the Apollo astronauts on the Moon, Mars suits protect astronauts from extreme temperatures and the very thin, non-breathable atmosphere.

COMMUNICATIONS SYSTEM:

The communications system will consist of two communications satellites and Earth ground stations. It will transmit data from Mars to Earth and back.

Mission to Mars

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Mars Space Suit

MARS TRANSIT VEHICLE

The transit vehicle will consist of two propellant stages, a landing module, and a transit habitat. The landing module will be similar to the ones used for the unmanned Mars missions. The crew will travel through space for approximately seven or eight months, depending on the year of departure, which is much shorter than many MIR Station missions and even shorter than the new one year shifts in the ISS. The transit habitat will be a small space station when compared to the vast ISS module.

The water tanks and other storage equipment will be used to create a radiation shelter that will also function as crew sleeping quarters. When the crew arrives on Mars, they will descend to the Mars surface in their Mars suits in the landing module. They will then leave the transit habitat behind because it is too large and too heavy to land. This means that the transit habitat needs a lifetime of only the duration of the journey to Mars, which is much shorter than ISS modules.

LAUNCHER

Mars One will choose the right launch supplier from existing, experienced companies.

SIMULATION OUTPOST ALPHA

Mars One will create several Earth-based simulation outposts for training, technology try-outs, and evaluation. Both on Mars and Earth, the Mars One outpost will become the epicenter for the mission. On Earth, it will provide assessment and training, and on Mars, it will provide a safe home for the crew. The outpost design is based on six assembled transit modules and two additional inflatables making up living quarters, private areas, food production, life support systems, surface access, recreational areas, mission operations, life science and much more. On Mars, the outpost will expand as more astronauts arrive, creating more living space and ever-changing environments for the permanent settlement.

OUTPOST

Simulation Outpost Alpha will be the first prototype of many - providing a training facility on Earth and familiarisation for life on Mars.

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Mission to Mars

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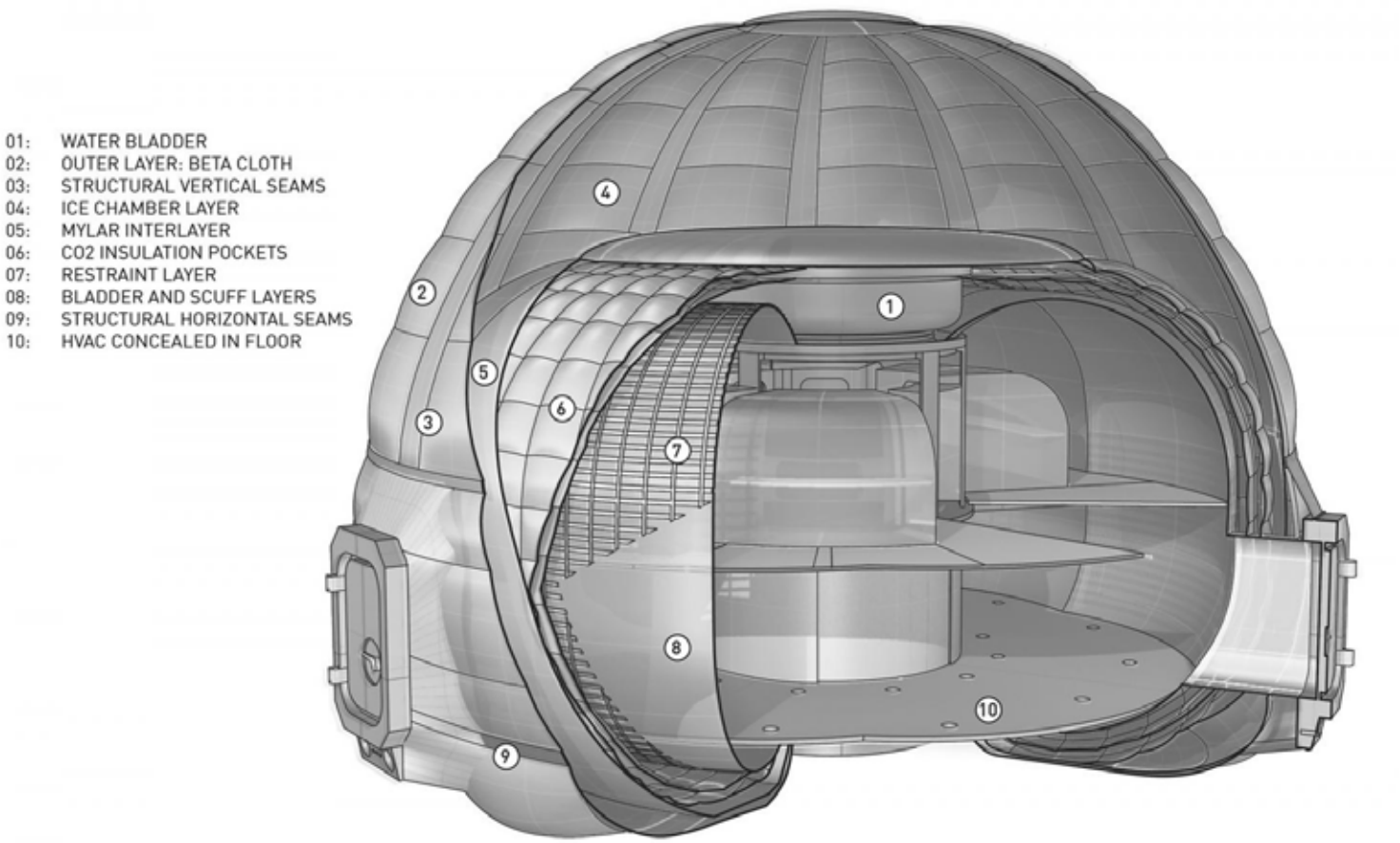

Proposed Living Quarters on Mars

TECHNOLOGY

The construction technology behind Outpost Alpha will match the simplified level of outpost complexity. The entire outpost will be made of rigid modules - even the "inflatable" volumes. Mars One is working towards a production method that allows for easy container shipping, easy assembling techniques, and potential module parts replacements.

COMPLEXITY

Before being sent to Mars, every astronaut must be familiar with the outpost architecture, daily living routines, group dynamics, and the technology that runs the "city."

The simulation outpost on Earth is a perfect tool for such familiarization and learning how to diagnose and fix outpost subsystems.

As the expansion of the simulation outposts increases, so will the complexity of the structure increase. Simulation Outpost Alpha is a simplified hard-shelled construction with only very basic subsystems for atmospheric control and general safety.

There will be no working airlocks and no internal pressure, both of which are required on Mars to hold the outpost structure intact.

Later outposts will present all subsystems required for Mars and the complexity to operate hatches, subsystems, communications, and life support.

LOCATION

Multiple locations on Earth will be chosen to hold various types of the outpost permanently. Each area will pose different possibilities and scenarios for testing astronaut candidates. The initial locations will have a boundary for easy technology testing and easy access to PR.

The Arctic and other remote regions around the world will be chosen for (psychological) measurement of the astronauts and

equipment related testing for wind, dust, temperature, and isolation.

The general architecture layout and the interior design are some of the most critical issues to address regarding the outpost. These features will not only provide public safety but will also create a comfortable and enjoyable living environment.

ARCHITECTURE

The outpost architecture consists of six lander modules and two elongated inflatables. The central area is inside the inflatables, providing approximately 200 square meters for daily living and food production.

The two centered lander modules will provide access technology to the Martian surface, and the four remaining lander modules will mainly contain subsystems supporting the entire outpost.

INTERIOR DESIGN

Designing the interior is an exciting task, which is soon to begin. The interior design has to fulfill the needs of both the everyday tasks and the entire life cycle for a human being and crew. Additionally, it must also comply with the requirements of allowed mass and volumes to be transported and later "unfolded" inside the outpost.

A great deal of flexibility has to be integrated into the interior design, making changes possible for special occasions or new situations in life.

Dedicated interior areas and functionalities will be chosen for initial prototyping and evaluated during astronaut training.

MISSION FEASIBILITY

Many design decisions make Mars One's plan feasible:

PERMANENT SETTLEMENT

The Mars One crews consist of people that want to settle on Mars. The absence of a return mission reduces the mission infrastructure radically. No return vehicle, return propellant or the systems to produce the fuel locally are required. The permanent settlement also reduces the development of technology needed; vehicles that can take off from Mars and return to Earth are currently unavailable and untested. Since the vehicle returning to Earth and the accompanying systems are mission critical for a return mission, they need to also deliver backups, adding to the infrastructure to Mars. More importantly, to attain a somewhat acceptable risk level, the return mission would need to be tested in a complete unmanned return trip before the first crew even departs the Earth. The risk for the team to ride the first return rocket will be extremely high, even after a full return-system test is successfully performed.

The permanent settlement also solved the challenge of the astronauts entering into Earth's atmosphere after having spent about two years in reduced or zero gravity environments.

USE OF IN-SITU RESOURCES

Mars has resources that can be used for a sustainable settlement. Water is present in the soil and can be made available to the settlement for hygiene, drinking, and farming. It is also the source of oxygen

Settlement Expansion

Mission to Mars

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generated through electrolysis. Nitrogen and argon in the Martian atmosphere can be mined to be the inert part of the atmosphere inside the habitat. Martian soil will cover the outpost to block cosmic radiation. Carbon dioxide can be taken from the atmosphere if the plants take in more than the humans expel.

The systems to mine water from the soil and nitrogen, argon, and carbon dioxide from the atmosphere have never been tested in space. Mars is however a planet, because there are gravity and a thin atmosphere. Additionally, the processes are all more than 100 years old. The water will be harvested from the soil by breaking it up with a drill and collecting the resulting debris. Argon and Nitrogen can be obtained from the atmosphere by removing the carbon dioxide through a phase change.

SOLAR PANELS

The Sun is a reliable, robust, and plentiful energy source. Using solar panels is the best choice for Mars One since it takes away the requirement to develop and launch a nuclear reactor, thereby saving time and money while avoiding the risks and concerns of the use of a nuclear power source.

Thin film solar (photovoltaic) panels will power the Mars One settlement. These are less efficient than those more commonly used in aerospace, but have the advantage of being extremely light, and are thus readily transportable. The first settlement will install approximately 3000 square meters of power generating surface area.

EXISTING TECHNOLOGY

No new significant developments or inventions are needed to make the mission plan a reality. Established suppliers can build each stage of Mars One mission plan. While most of the components required are not immediately available with the exact specifications, there is no need for radical modifications to the current component designs.

Every effort was made to design the mission with as little complexity as possible. The choice to send permanent settlers removes the need for a substantial lift launch vehicle, which does not currently exist. The permanent settlement makes the landing module small enough to land with current technology. A pressurized rover will not be sent to Mars until large enough rockets exist. No water recycling in the transit habitat will be present because the trip to Mars takes only 210 days. Instead, all necessary water is stored in tanks that also function as radiation shielding. Storage, of waste that is not easily recycled, is available in the settlement until more technology is available.

INTERNATIONAL YET APOLITICAL

Mars One is a non-governmental company and is apolitical in its function. Suppliers are chosen on a balance of price and quality, not through political or national preferences.

The astronaut selection process have engaged tens, even hundreds of thousands of applicants from different countries worldwide. Each team selected for settlement on Mars will consist of four people, each from a diverse nation on Earth. From start to finish, from Earth to Mars, Mars One is dedicated to an international, intergenerational effort to take the human species to its next home planet. Besides, Mars One has no internal technology development; this is done entirely by consultants that specialize in the field. Furthermore, Mars One does not have its hardware development centers that can push the use of their technologies.

RISKS AND CHALLENGES

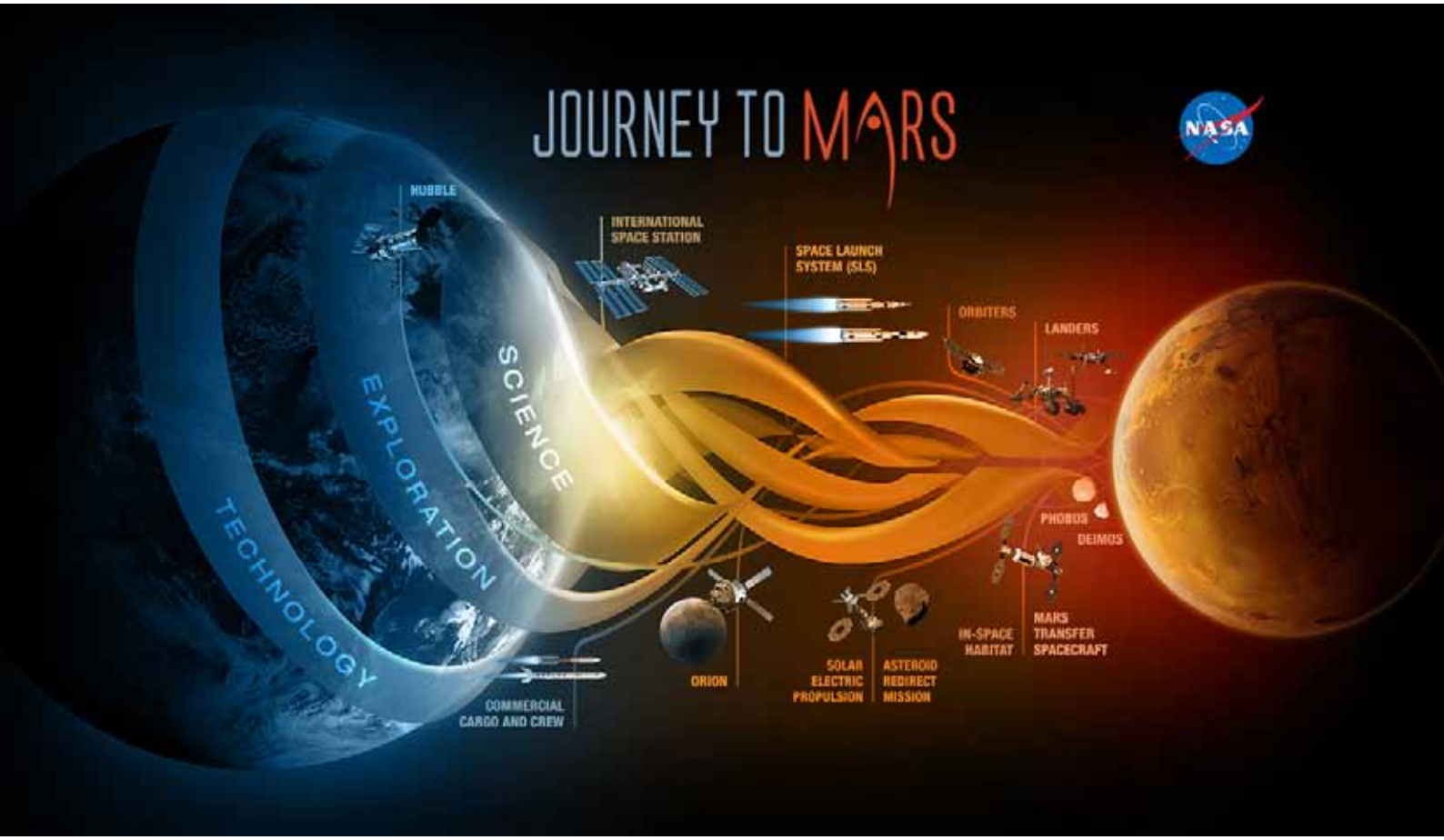
Mars One has developed a mission to establish a human settlement on Mars built entirely upon existing technology. While the integration of systems proven in previous missions does significantly improve the chance of success, it by no means eliminates the risk or challenge of such an incredible endeavor. Sending humans to Mars remains a phenomenal undertaking by all standards and, as such, presents genuine dangers and difficulties.

United States President John F. Kennedy said in his famous Rice Moon speech *"We choose to go to the Moon, not because it is easy, but because it is hard."*

Mars One takes on the challenge of establishing a settlement on Mars with the same frame of mind, knowing all great endeavors, especially space exploration, incorporate the risk of lost time, resources, and sometimes lives. Venturing to Mars is no exception.

The challenge is to identify the risks in every step of the ten-year mission, from astronaut selection through training, from launch to living on Mars. Mars One has incorporated into its mission plan a detailed risk analysis protocol, built by highly experienced individuals, some of them with experience at NASA and the ESA.

Ever evolving, ever improving, Mars One is continually working to reduce the risk of delay and failure at every level.



For example, the Mars lander will be tested several times before the landing of the first crew, using identical vehicles.

As is standard in the aerospace industry, every component will be selected for its simplicity, durability, and capacity to be repaired using the facilities that are available to the astronauts on Mars.

An essential aspect of risk management is the quality of the information to be shared between suppliers and all relevant parties. In the case of the Mars One mission, this includes sponsors, investors, aerospace suppliers, and of course, the astronauts themselves. Because the mission is ultimately funded and supported by the global audience, Mars One also desires for the general public to have a sense of what the risks are and how Mars One is working to mitigate them. Mars One identifies two major risk categories: the loss of human life and cost overruns.

HUMAN LIFE

Human space exploration is dangerous at all levels. After more than fifty years of humans traveling from Earth to space, the risk of space flight is similar to that of climbing Mount Everest.

Mars is an unforgiving environment where a small mistake or accident can result in tremendous failure, injury, and death. Every component must work flawlessly. Every system (and its backup) must function without fail or human life is at risk.

With advances in technology, shared experience between space agencies, what was once a one-shot endeavor becomes routine, and space travel does become more viable.

COST OVERRUNS

Cost overruns are also not uncommon in large projects in any arena. The risk for cost overrun in the Mars One mission is reduced by using existing technologies, and by the fact that about 66% of the value is associated with launch and landing - both of which are well understood and proven variables. The proposed Mars One budget includes a significant safety margin to take into account essential mission failures as well as smaller but costly failures of components on Mars.

Mission to Mars

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Mars One has developed a detailed risk analysis profile which guides both its internal technical development as well as the relationships it builds with its aerospace suppliers. This risk analysis profile will continue to evolve and improve over the years before the first humans walking on the planet Mars.

JOURNEY TO MARS

The flight will take between seven to eight months (depending upon the relative positions of the Earth and Mars). The astronauts will spend those seven months together in a tiny space - much smaller than the home base at the settlement on Mars - devoid of luxury or frills. It will not be easy. Showering with water will not be an option. Instead, the astronauts make do with wet towelettes (wet wipes) as used by astronauts on the International Space Station.

Freeze dried and canned food is the only option. There will be constant noise from the ventilators, computers, and life support systems, and a regimented routine of three hours of daily exercise to maintain muscle mass. If a solar storm hits the astronauts, they must take refuge in the even smaller, sheltered area of the rocket which provides the best protection, for up to several days.

The journey will be arduous, pressing each of them to the very limits of their training and personal capacity. However, the astronauts will endure because this will be the flight carrying them to their dream.

LIFE ON MARS

Once they arrive on Mars, the astronauts will begin making use of their relatively spacious living units; over 50 m^2 per person, and a total of more than 200 m^2 combined interior space.

Within the settlement are inflatable components which contain bedrooms, working areas, a living room and a 'plant production unit,' where they will grow greenery. They will also be able to shower, as usual, prepare fresh food (that they produced and harvested) in the kitchen, wear regular clothes, and, in essence, lead typical day-to-day lives.

If the astronauts leave the settlement, they have to wear a Mars suit. However, all living spaces are connected by passageways, for the astronauts to move freely from one end of the settlement to the other. As the rovers have done much of the heavy construction before their arrival, it will not take the astronauts a long time to find routine in their new life, moving into carrying out valuable construction works and research.

CONSTRUCTION & RESEARCH

Several new components will be delivered to Mars while the first group of four astronauts settles. In preparation for the arrival of the second group of four astronauts, the components will include a second living unit and a second life support unit. With the use of the rovers, the astronauts will connect these units to the main base. When this task is completed, the first crew will prepare the settlement for the arrival of additional astronauts, and, in the meantime, the astronauts will enjoy more room for themselves and extra safety as the duplicate living environments provide backup life support systems.

When the second crew of astronauts lands, the first crew will have already applied technology and physical labor to the construction of additional living and working spaces, using local materials. Mars One is working on concepts, such as the inclusion of tunnels and domes made from compressed Martian soil, which may be able to hold a breathable atmosphere for the astronauts. There will be a great deal of research conducted on Mars. The astronauts will research how their bodies respond and change when living in a 38% gravitational field, and how food crops and other plants grow in hydroponic plant production units. The research will include extra-settlement exploration to learn about the ancient and current geology on Mars. Of course, much research will be dedicated to determining if life was once present or currently exists on Mars.

REPORTS FROM MARS

The astronauts will not only submit regular reports but will also share all that they enjoy and find challenging. It will give Earthlings a unique and personal insight view of life on Mars. The "Marsians" could answer intriguing questions like: What is it like to walk on Mars? How do you feel about your fellow astronauts after a year? What is it like living in the reduced Mars' gravity? What is your favorite food? Do you enjoy the sunsets on Mars?

Perhaps we can start a new Reality TV show then "Big Alien-brother" and follow the "Marsians" around - you never know - only time will tell! wn

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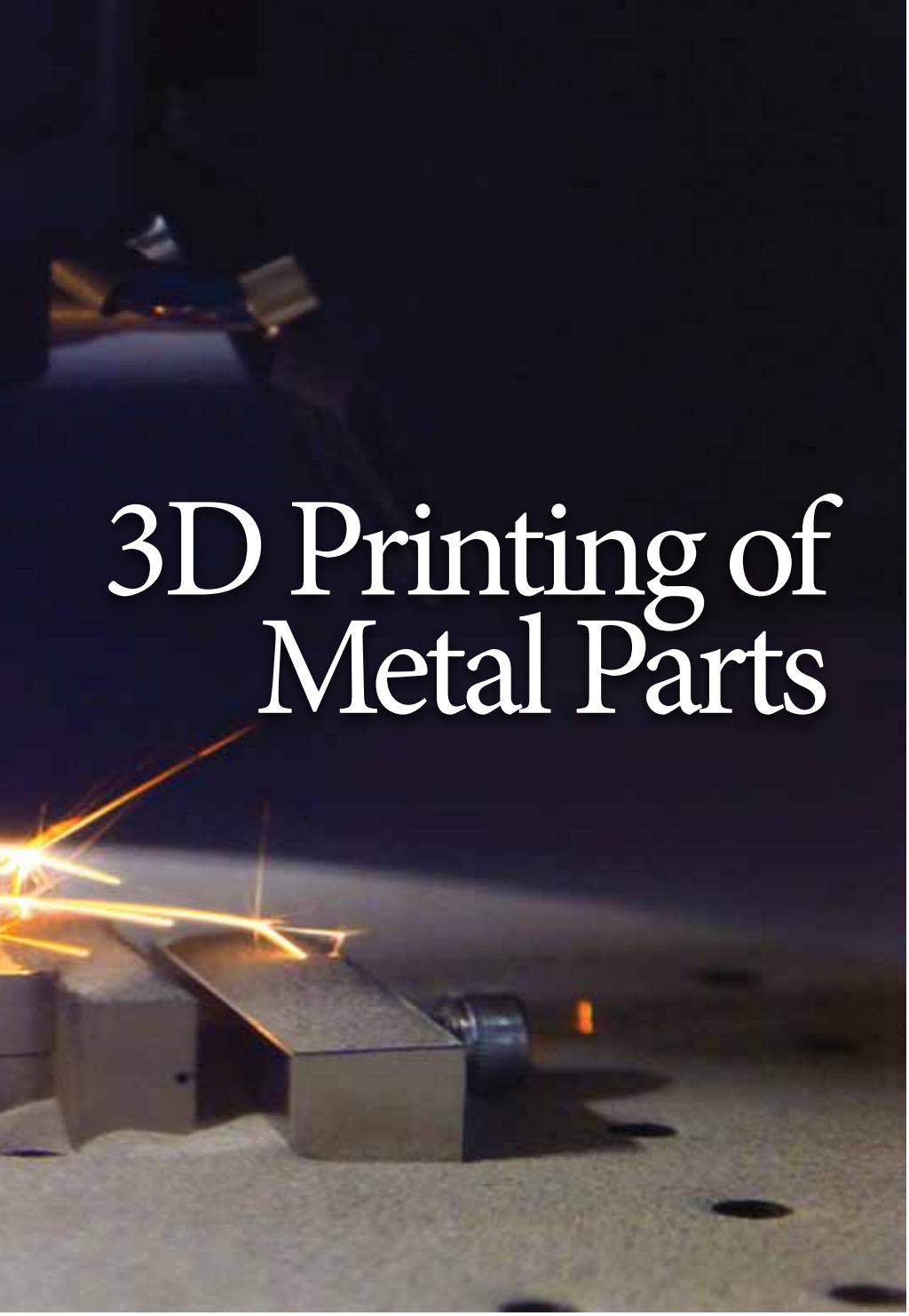
The vast majority of 3D printing technologies focusses on making objects out of plastic, but 3D printing technologies are being developed to build metal objects, generally by laser-sintering powdered metal feedstock. The hope of the universities and corporations pursuing the technique is that the ability to print metal parts will bring about a revolution in industrial production by supplanting traditional metalworking methods like forging.

Are we on the threshold of such a revolution? Will 3D printing displace forging, especially for custom parts? Nobody can say for sure what will happen tomorrow, but one question that we can address today is this: Which would be the better choice for making parts for use in the aerospace, medical, and other industries? This article explores that question.

KNOW THE APPLICATION

A good starting point is to consider the-where and the-how of the use of the parts carefully. At present, there are many unknowns with 3D metal-printing technology, and while it's entirely possible the technology may make significant inroads as time goes on, right now



3D Printing of Metal Parts

3D printing is Additive Manufacturing (AM) technology used to build objects layer-by-layer directly from digital data. It has surged in popularity in recent years because it enables fast and flexible product design and prototyping, and can be used to produce small numbers of parts cost-effectively, and create intricate pieces that are difficult or impossible to make otherwise.

it seems best-suited for applications where the goals are:

- to reduce the total number of parts in a system;
- to make pieces that can't readily be made by another means (complex geometries with internal channels, for example); or
- to reduce weight.

Forging, meanwhile, remains the best choice for applications where mechanical concerns such as strength and durability are vital requirements, which is primarily crucial with non-ferrous metals that include some of the softest and most ductile metals in the world. Forging allows engineers to use raw materials and unique processes that address an application's specific requirements.

For example, for the highest-strength copper parts, it is imperative to start with a raw material that has the proper chemistry requirements needed to achieve particular grain size, hardness, or other mechanical characteristics required for the application. The absence of raw material defects is critically important in many industries, which, along with an appropriate reduction ratio and grain orientation, results in the most reliable part possible given its desired shape, size, and function.

Also, the use of particular alloys often is required to meet electrical or thermal conductivity specifications, to address

3D metal printing

continues from page 51

welding or brazing considerations, or to meet government regulations or industry standards that may apply to the application. It is business as usual in the forging industry, but given the newness of the 3D metal-printing technology and the variable characteristics of sintered metal powders, it isn't clear how users can always rest-assured of meeting such requirements.

PRODUCTION SPEED

Speed is often advocated as a significant advantage of 3D printing technology, especially for small numbers of custom parts. This comes from the fact that designers are working directly from digital models, so fewer prototypes are required, and the prototypes that are necessary can be created quickly and relatively inexpensively with no need for special tooling, setup, or assembly.

But while this often may hold true for parts made from plastic resins, when it comes to metal parts, the issue of production speed has many other dimensions that are often left unmentioned. Anyone choosing between 3D printing or custom forging based merely on anticipated production speeds would do well to look at the issue from a broader perspective.

The first consideration is the rated build speed of 3D printing equipment. Just because a car can travel at 200 KPH doesn't mean it will ever drive that fast. Similarly, with 3D printers, output quality can go down at higher build speeds, and since many custom non-ferrous parts must meet exacting specifications, the printer may never actually run at its rated build speed, and the production of components may take longer than anticipated, mainly if they are large.

Forging allows engineers to use raw materials and special processes that address an application's speci c requirements.

On the other hand, open die-forging can produce custom prototypes not only faster than any different forging process but fast in absolute terms. For example, while production speeds vary depending on the given part, custom prototypes can be fabricated in as little as 2 to 4 weeks.

For more significant quantities of parts than just a few prototypes, some people envision "farms" of 3D printers to meet delivery requirements, but this remains to be seen. Another speed-related issue to consider is the common misconception that once a part comes out of a 3D printer, it is immediately ready for use. Post-production processes may be required with metal parts, delaying delivery to the customer. For example, take the support structures used during printing. These may be used to anchor a piece to the build plate, so it doesn't move during the printing process, or to provide a path for heat transfer, so the metal powder isn't over-heated during laser-sintering. In any event, the support structures must be removed from the finished part. That not only takes time, but their removal can inadvertently create quality issues with some parts destined for critical applications, and time must be devoted to addressing them.

Heat treating is another potential post-production need because some 3D-printed metal parts can deform or crack from residual stresses once it's built. These stresses may arise from factors such as the material used, or localised heating and cooling that may have taken place in some areas of the part, given the varying thicknesses of its walls and other structures.

AVAILABILITY OF TECHNICAL SUPPORT

Another critical issue to consider when weighing the trade-offs of 3D printing versus forging is whether the supplier offers the needed engineering and technical support to help customers achieve desired levels of performance and quality.

For example, it isn't easy or straightforward to properly heat-treat many soft, ductile alloys. It requires specialized expertise. Time and temperature requirements must precisely adhere to achieve the optimum results, and the method of heating, furnace design and furnace atmosphere all contribute to the success of making

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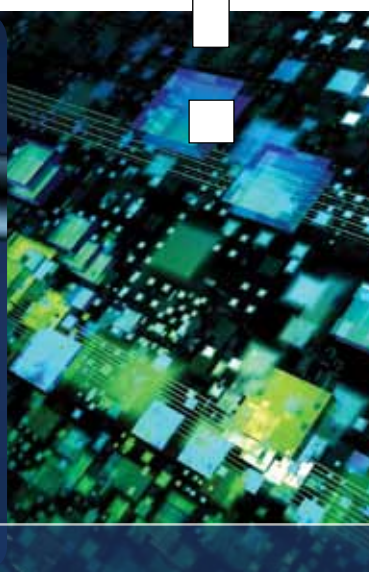

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3D metal printing

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the desired properties. Specialised expertise may also be needed for testing, analysis, and other technical issues with certain alloys.

It raises the question of who would be doing the 3D printing. Would it be a service arm of the 3D printer manufacturer whose expertise probably lies more in printing technology than in metallurgy? Would it be an independent service bureau, which may or may not have the necessary knowledge, depending on its background and specialization? Would it be the customer itself, who may be able to take care of all resulting technical issues?

ADDITIONAL CONSIDERATIONS

Safety – Safety is a vital concern in aerospace, medical, and other critical applications, and the ability to ensure high quality and to trace the pedigree of a part in the event of failure is a significant capability.
3D printing of metal parts is in its early stages so the needed processes and procedures may not yet be fully developed.

Unique Alloys – Some says that an advantage to the use of 3D printing is that the powdered metals used can be custom-tailored so that parts can be made of specialized alloys. But that is hardly unique.

CONCLUSION

3D printing of metal parts has received much attention recently, and while its future is undoubtedly bright, it has limited applicability at present. It may best be viewed as a complement to the forging of non-ferrous metal parts, which remains the best choice for most applications. wn

Time and temperature requirements must be precisely adhered to in order to achieve the optimum results.

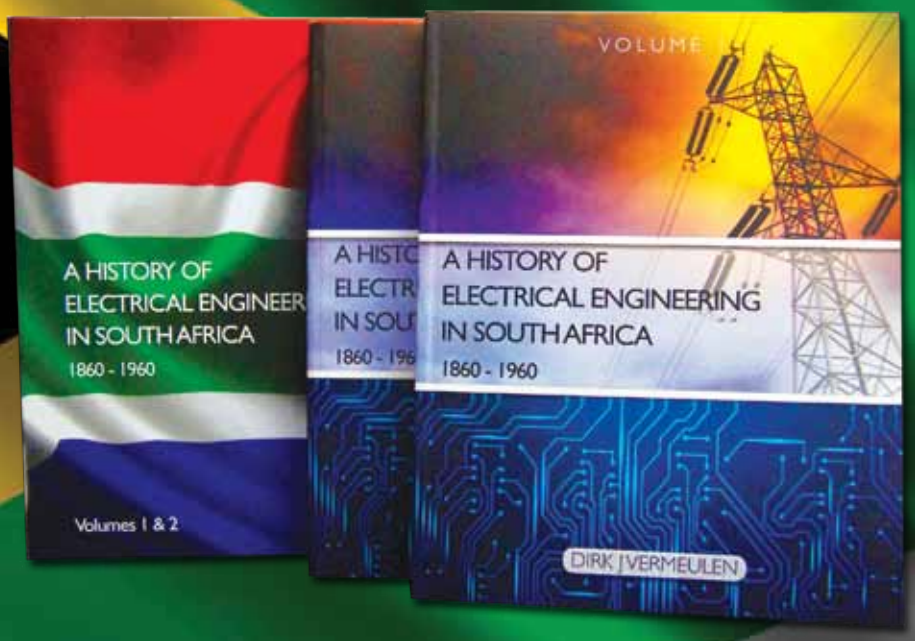
For the highest-strength copper parts, it is imperative to start with a raw material that has the proper chemistry requirements for the application.

Open die forging can produce custom prototypes faster than any other forging process.

A HISTORY OF ELECTRICAL ENGINEERING IN SOUTH AFRICA

1860 - 1960

BY DIRK J VERMEULEN



Most people take the fruits of electrical engineering for granted, and know little about their origins. Electrical engineers have contributed enormously to the growth and prosperity of South Africa. This book attempts to tell some of their stories.

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IN MY OPINION - CHRISTOPHER R. TSCHAN

Recommendations for Intelligent Systems Development in Aerospace

Intelligent systems technologies (IS) have started to catapult aerospace systems to new levels of performance, efficiency, capability, and resilience. Examples include the recently demonstrated "refuse-to-crash" technology [1], autonomous aerial refueling [2], and SpaceX landing of the first stage of its Falcon 9 rocket on a barge at sea [3]. In the near future, intelligent systems technologies are expected to play a central role in technology development for numerous types of aerospace systems. As such, policies and research priorities concerning intelligent systems development need to be formulated.

BY | CHRISTOPHER R. TSCHAN

OPINION

The AIAA Intelligent Systems Technical Committee (ISTC) is committed to: increase awareness and improve communications on intelligent systems technologies; establish system requirements; and accelerate technology development. The AIAA ISTC advocates a multifaceted approach to research, development, and the implementation of intelligent systems for aerospace.

This opinion paper supplements the recently released *"AIAA ISTC Roadmap for Intelligent Systems (IS) in Aerospace"* [4] by providing recommendations to the aerospace industry, research and educational institutions, and relevant government agencies. The resulting development in IS technologies is expected to make the aerospace industry more innovative, safer, efficient, and sustainable.

INTRODUCTION AND PROBLEM STATEMENT

For this opinion paper, "Intelligent Systems" (IS) is used as a broad umbrella term that covers, among others: adaptive systems, artificial intelligence, robotics and autonomous systems, swarm information, evolutionary systems, and cognitive assistance. An IS can be a physical system or exist in a software form. It can work alone, as part of a more complex system, or be teamed with other intelligent systems or humans.

A significant number of IS technologies are starting to appear in everyday applications. These technologies range from an ever-increasing number of smart safety features in cars and automated driving to personal assistants on computers and mobile phones. However, the integration of IS technologies into actual aerospace products has been slow. The rapidly growing civilian Unmanned Aircraft Systems (UAS) sector and the strengthening private space industry have brought an infusion of people, ideas, and cultural influences from other disciplines (e.g., information technology, entertainment, etc.) into the aerospace industry. While aerospace systems are becoming more intelligent, the potentially transformative impact of IS in aerospace is not well recognized, and, sometimes, seen as a point of concern. The level of risks associated with aerospace systems and the degrees of high confidence and reliability often required by aerospace industry and certification authorities affect the pace of IS development and applications in the industry. This presents both a challenge and an opportunity for the IS community.

VISION

The future is promising for a community of government, academia, and industry innovators that understands the benefits of aerospace intelligent systems technologies. Breakthroughs in performance, safety, and efficiency for aviation and space systems due to IS may soon appear with regularity. Revolutionary designs and systems that were not possible to build without IS technologies will become more common. IS will also help reduce the cost of system development and operations in the aerospace sector. People will better understand the substantial benefits and potential risks that are brought by the intelligent systems technology in the future.

Intelligent Systems Development

continues from page 57

The potential benefits of intelligent systems technologies could well balance the costs and risks associated with their development and adoption. Some of the specific benefits are:

- Adaptive, increasingly autonomous aerospace flight capabilities can improve efficiency, enhance performance and safety, reduce noise and emissions, better manage system and operational uncertainty, as well as optimize both short-term and long-term system behaviors;
- Computational intelligence techniques can explore large solution spaces and provide real-time decision- making and re-planning capabilities for complex problems;
- Intelligent Integrated System Health Management (ISHM) systems can perform monitoring, anomaly detection, diagnostics, and prognostics in a more systematic and affordable manner;
- Human-machine integration ensures that IS work in a way that is compatible with people by promoting predictability and transparency in action, and supporting human situational awareness;
- Intelligent Systems can contribute to real-time solutions for air traffic control and strategic air traffic flow management, and provide human-decision support or autonomous disruption recovery to quickly and robustly respond to and efficiently recover from disruptions;
- Increased intelligent automation in ground-systems for domains such as space operations can help reduce human errors, avoid spacecraft anomalies, extend mission life, increase mission productivity, and minimize space system operating expenses;
- Autonomous robots not only can free people from dull, dirty, and dangerous jobs, but also can work alongside with humans to enhance their capabilities;
- IS can extend humankind's reach into hazardous or inaccessible environments, making timely decisions and appropriate responses at appropriate speeds, and help manage complex networked systems;
- Machine learning algorithms can help discover knowledge, gain insight, and improve understanding of mass amounts of data being collected throughout the operation cycles of aerospace systems;
- Intelligent design assistance software can help create future systems that people cannot envision today.

For this vision to materialize, the aerospace community needs to formulate and implement policies and identify research priorities that will accelerate technology development of intelligent systems.

RECOMMENDATIONS

The AIAA ISTC has formulated a comprehensive "Roadmap for Intelligent Systems in Aerospace" [4]. In addition, the ISTC makes the following recommendations to facilitate the healthy and coherent growth of the aerospace intelligent systems community:

- Reduce the barrier between aerospace and other domains (e.g., the automotive industry and the information technology sector) to allow more natural technology exchanges;
- Support, create, and publicize successful examples of intelligent systems in the aerospace sector;
- Be proactive in proposing progressive policies for the successful and safe implementation of IS for aerospace;
- Educate the workforce to recognize where and how IS technologies could be deployed to create new capabilities, improve performance and safety, and enhance operation;
- Look for more opportunities to bring research into practice, recognizing the rapid development of tools and prototypes for making intelligent systems technologies more accessible for industrial practice.

RECOMMENDATIONS TO RESEARCH AND EDUCATIONAL INSTITUTIONS:

- Collect data and document the risks and benefits of IS to foster public and corporate acceptance and trust. For example, provide perspective on the safety record of humans, human-machine teams, and autonomous systems to identify how IS can best enhance the safety and efficiency of civil aviation, and to identify and develop new verification and validation technology required for specific technology areas;
- Create benchmark problems and shared datasets, platforms, and open-source libraries that can stimulate collaboration in intelligent systems research;
- Provide an interdisciplinary and research-friendly environment for aerospace engineering students to interact with students from different backgrounds such as computer science and robotics;
- Enhance intelligent systems-related curriculum with an emphasis on solving real-world problems;
- Develop education and outreach initiatives, including interactive tutorials that help everyone from aerospace researchers to the general public,

understand how IS work and what they can do to enable new capabilities in aerospace systems.

RECOMMENDATIONS TO GOVERNMENT AGENCIES:

- Recognize the interdisciplinary nature of IS technology and support cross-cutting developments;
- Increase support of long-term, high-risk, but potentially transformative IS research;
- Support experimental e orts that can lead to demonstrations of physical systems and support business development in high technology readiness-level areas to create success stories;
- Support breakout events, such as a series of Intelligent Systems Grand Challenges to stimulate innovation, foster healthy competition, and demonstrate IS technologies;
- Collaborate with international partners to set precedents through constructive development and applications of IS in aerospace;
- Support the development of new verification and validation techniques for IS that will provide regulators with a sound methodology for certifying aerospace systems containing IS;
- Recognize the increasingly important role of intelligent systems in traditional aerospace disciplines and new capabilities that could be brought about by IS in future aerospace missions;
- Establish baseline research capabilities to fund promising IS that could have a high potential payoff —in the same way, that baseline research funding is done for traditional aerospace disciplines such as computational fluid dynamics and propulsion. wn

REFERENCE

1 Norris, G., "Auto-GCAS Saves Unconscious F-16 Pilot—Declassified USAF Footage," Aviation Week, Sep 13, 2016, Available: http://aviationweek.com/air-combat-safety/auto-gcas-saves-unconscious-f-16-pilot-declassi ed-usaf-footage

2 Myers, M., "Unmanned X-47B jet completes first aerial refueling," NAVY Times, April 2015, available: https://www.navytimes.com/story/military/2015/04/22/navy-navair-x-47b-unmanned-jet-refueling/26191213/

3 Co eld, C., "SpaceX Sticks a Rocket Landing at Sea in Historic First," Space.com, April 2016, available: http://www.space.com/32517-SpaceX-sticks-rocket-landing-sea-dragon-launch.html

4 AIAA ISTC, "AIAA ISTC Roadmap for Intelligent Systems in Aerospace," 2016, available: https://info.aiaa.org/tac/isg/ISTC/Shared%20Documents/Roadmap%20for%20Intelligent%20Systems%20in%20Aerospace/AIAA_Roadmap_for_Intelligent_Systems-v1.0_14Jun2016.pdf

This paper was written in 2016 and 2017, with the rst draft developed by Christopher R. Tschan, submitted to AIAA for review in May 2017, and approved by the AIAA Public Policy Committee and the Technical Activities Division in December 2017. The Intelligent Systems Technical Committee (ISTC) consists of AIAA members who, as a group, possess a breadth of experience in intelligent systems technology, policy, and operations. This statement re ects the collective expert view of the ISTC and is not necessarily a position of AIAA at large.

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We look forward to hearing from you.
- Ed

QUESTION ONE
What are the main reasons for contactor failure?

ANSWER ONE
The failure of contactors – of which the a.c. air-break contactor is the most widespread switching device used in motor starting – is a common event, but often the reason for the failure is not well understood. The performance of each contactor is well documented under test conditions (according to IEC60947-4-1 and UL 508) and if the application only operates the contactor within its defined operating parameters then a lifespan consistent with its published ratings can be expected. If the contactor is subjected to a stress outside its ratings, however, rapid failure can sometimes result.

While the contactor is a fairly simple device, it represents many years of research and development. The performance of contactors has been refined to the point where confidence can be placed on the published ratings, but one should not expect a reserve outside of these ratings. Contactor failure as a result of manufacturing or design defects is a rare event. Careful examination of all the factors involved will usually find the cause of failure to be other than the contactor itself.

An understanding of the possible causes of early failure is helpful in evaluating failure in service. The most common problems with contactors are flashover (electrical breakdown between phases) and contact welding.

QUESTION TWO
What is the likelihood of flashover?

ANSWER TWO
The compact design of modern IEC contactors means the phase separation is small. Flashover between phases does occur, but usually these instances can be traced to connection problems. Internal flashovers are rare and should never be found on a contactor operating within its design limits.

Experience in the industry is that significant deterioration of the insulation between phases can generally be identified only in contactors that have reached the end of their design life. Flashover may result only in extreme cases.

QUESTION THREE
What causes contact welding?

ANSWER THREE
Welding of the contacts is the major cause of contactor failure. Contact welds that are

of sufficient strength to prevent opening and can usually be traced to an abnormal condition in the external circuits. While such welding is common, the welds tend to be very minor at normal current levels and the operating spring will break the weld.

Among the abnormal conditions that may be experienced in the control circuit is voltage sag, which can cause the contactor to 'chatter'. This chattering occurs when the magnetic force of the contactor coil system is insufficient to ensure proper closing of the moving contacts.

According to the standards, contactors must still operate perfectly at 80% of Us rated control supply voltage. The contactor may chatter if the voltage is lower than this under voltage tolerance of 20% at the instant of closing; for example, when a large load is being switched on in a weak network and the voltage drops owing to the starting current the moment that the main contacts touch.

During chattering, the contactor operates at a switching frequency up to twice the frequency of the supply voltage and it is thermally overloaded by the switching arcs.

It usually becomes jammed in a position in which the contacts touch and weld together. Besides welding of contacts, chattering commonly causes coil burning or flashover. It is common that almost every manufacturer's contactors are tested to find this 'intermediate' position of rapid opening and closing.

QUESTION FOUR

What is the expected electrical life of contactors?

ANSWER FOUR

The electrical life of contactors is defined by the total number of possible operating cycles under specified operating conditions before its contacts are worn out – that is, when the contact material is eroded away. The contacts are stressed during opening and closing operations under load.

Contact erosion is mainly caused by the breaking of arc current which burns between contact pieces during opening operation. During closing operation, moving contact pieces are subjected to bounce that also causes arc erosion.

Manufacturers provide details of the expected service life of contactors by testing them under standardised conditions.

Since contactors are used in a great variety of applications, the expected number of operating cycles may range from a few thousand to one million cycles or more.

The specific type of application also determines the stress of the contacts and the resulting lifespan. The contactor lifespan is influenced (under AC loads) by the following factors in their order of importance: making and breaking current; voltage; power factor; switching frequency; and ambient conditions such as climate, temperature and vibration.

QUESTION FIVE

What is permissible switching frequency?

ANSWER FIVE

Permissible switching frequency is expressed in terms of the permitted number of switching cycles or 'make/break' operation per hour, and depends on the rated operating current of the particular utilisation category in question.

Theoretically, the maximum permissible switching frequency is the no-load switching frequency of the device. In comparison to continuous operation, however, a high switching frequency causes increased heating. The reasons for this include repeated, high starting currents after closing, as well as the heat caused by the switching arcs during opening. wn

Information provided by Zest WEG Group

LOOKING BACK ...

April

Movers, shakers and history makers

COMPILED BY | JANE BUISSON-STREET
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1 APRIL

1999 The National Research Foundation (NRF) was established as an autonomous body providing postgraduate research training support for the development of science and technology in SA.

2 APRIL

1902 Tally's Electric Theatre in Los Angeles opened its doors. It was the first permanent movie theatre designed and built specifically for the exhibition of films. Initially opening hours were from 7:30 - 10:30pm., but demand forced Tally to schedule matinee screenings. Both day and night showings were regularly sold out of their ten cent tickets.

3 APRIL

2010 The first-generation iPad went on sale in the United States; initially just the Wi-Fi version was available. The tablet computer was designed and marketed by Apple Inc.

4 APRIL

1994 Marc Andreessen and Jim Clark founded Mosaic Communications Corp., later renamed Netscape Communications Corporation.

5 APRIL

1242 The army of Alexander Nevsky of Novgorod (a medieval Russian state) fought a group of the Teutonic Knights at the border of Russia and Estonia, on top of a large frozen lake and only ended when the ice collapsed under several thousand of the Teutonic Knights killing them thereby giving victory to the Russians.

6 APRIL

1992 Microsoft released Windows 3.1, priced at $149.00, and went on to sell three million copies over the next two months. Windows 3.1 added multimedia extensions which supported sound cards, MIDI, and CD Audio, Super VGA (800 x 600) monitors

.

7 APRIL

1964 IBM announced the release of its "System 360" mainframe computer architecture that had five new models. It was IBM's most successful computer system of all time.

8 APRIL

1946 Minister of Industrial Production, Marcel Paul founded the Électricité de France (EDF) as a result of the nationalisation of around 1,700 smaller energy producers, transporters and distributors.

9 APRIL

1860 Using his phonautograph machine, Édouard-Léon Scott de Martinville made the oldest known recording of an audible human voice.

10 APRIL

1858 The Big Ben's 14 tonne bell was recast by Whitechapel Bell Foundry, after the original cracked after testing.

11 APRIL

1936 German computer pioneer Konrad Zuse filed for a patent for the automatic execution of calculations, a process he invented while working on what would become the Z-1, Germany's first computer.

12 APRIL

1888 A French newspaper mistakenly published Albert Nobel's obituary, describing him as "a merchant of death" due to his invention of dynamite. It was actually Albert's brother, Ludwig Nobel, who had died (at age 56, due to heart trouble). However, shocked by the newspaper's report, Albert Nobel began to seek a change in public opinion, which led to his decision to establish the Nobel Prizes.

13 APRIL

1998 Dolly, the world's first cloned sheep, gave natural birth to a healthy baby lamb.

14 APRIL

1998 Netflix, founded in 1997, launched their website through which customers could rent one of 925 digital video discs (DVD).

15 APRIL

1912 The RMS Titanic struck an iceberg four days into its maiden voyage. Over 1,500 passengers drowned when the ship sank early the next morning. The Marconi wireless equipment on board was used to call for help, effectively saving 700 people. It was stated that, *"Those who have been saved have been saved through one man, Mr. Marconi and his wonderful invention."*

16 APRIL

1946 A 21.19 carat diamond, that would come to be known as the Eureka Diamond, was discovered by a young boy and his little sister as they played in their family farm along the Vaal River. A man named Schalk van Niekerk visited the farm and, suspected that the rock might be a diamond offered to buy it from the children. Their mother decided to give it to him instead. Van Niekerk got the diamond verified and sold it for £ 500. The diamond made its way to Britain where it was displayed until 1967. De Beers, bought the Eureka diamond where it's now displayed at the Kimberly Museum.

17 APRIL

1944 Harvard University's President, James Conant, wrote to IBM founder Thomas Watson Sr. to let him know that the Harvard Mark I, developed in cooperation between the two, was operating smoothly.

18 APRIL

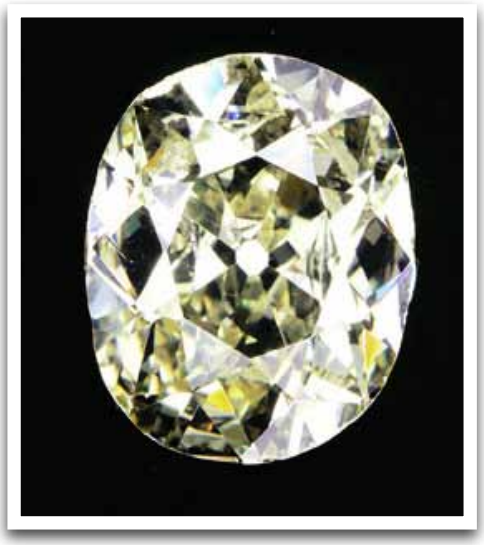
1986 IBM became the first computer manufacturer to use a megabit chip in a commercial product - Model 3090. This was seen as a major breakthrough for American computer makers as their work had been perceived as having fallen behind the Japanese electronics industry.

19 APRIL

2011 Fidel Castro resigns from the Communist Party of Cuba's central committee after 45 years of holding the title.

20 APRIL

2010 The Deepwater Horizon drilling rig explodes, killing 11 and causing the rig to sink, causing a massive oil discharge into the Gulf of Mexico and an environmental diaster.



APRIL

continues from page 63

21 APRIL

1989 Nintendo released the Game Boy, an 8-bit handheld game console, in Japan to coincide with their 100th anniversary. It was sold either as a standalone unit or bundled with the puzzle game Tetris.

22 APRIL

1592 Wilhelm Schickard, creator of an early calculating machine, was born in Germany.

23 APRIL

2005 Jawed Karim, co-founder of YouTube, posted the first video entitled "Me at the Zoo." Unfortunately, this isn't the most artistic of videos - it is a video of a man at the zoo looking at elephants and their trunks.....

24 APRIL

1914 **James Franck** and Gustav Hertz presented a paper to the German Physical Society in which they described their experiment (Franck-Hertz Experiment) which demonstrated the existence of excited states in mercury atoms, helping to confirm the quantum theory which predicted that electrons occupied only discrete, quantized energy states.

25 APRIL

1954 Researchers at Bell Telephone Laboratories demonstrated the first practical silicon solar cell.

26 APRIL

1986 World's worst nuclear disaster: 4th reactor at Chernobyl nuclear power station in USSR explodes, 31 die, radioactive contamination reaches much of Western Europe.

27 APRIL

1865 Steamboat "SS Sultana" explodes in the Mississippi River, killing up to 1,800 of the 2,427 passengers in the greatest maritime disaster in United States history. Most were paroled Union POWs on their way home.

28 APRIL

1611 Establishment of the Pontifical and Royal University of Santo Tomas, The Catholic University of the Philippines, oldest existing university in Asia and largest Catholic university in the world.

29 APRIL

1925 The first woman was elected to the U.S. National Academy of Sciences, Dr. Florence Rena Sabin of Baltimore, Maryland. She was a histology professor at Johns Hopkins University.

30 APRIL

2009 Chrysler automobile company files for Chapter 11 bankruptcy.

= Earn CPD Credits

calendar

MAY | JUNE | JULY 2018

MAY 2018

6 - 9	2018 IEEE Rural Electric Power Conference (REPC)	Mephis, USA	www.ieee.org
9 - 10	Collaborative Teams In Engineering	Johannesburg	roberto@saiee.org.za
10	Debate on the Restructuring of Eskom	Johannesburg	www.saiee.org.za
15 - 17	Africa Utility Week	Cape Town	www.african-utility-week.com
16 - 19	Planning Strategic Feasibility Studies	Johannesburg	roberto@saiee.org.za
20 - 24	IEEE ICC 2018	Kansas City, USA	www.icc2018.ieee-icc.org
21	Fluke Seminar Western Cape Centre	Western Cape	www.saiee.org.za
22	Fluke Seminar - Eastern Cape Centre	Port Elizabeth	www.saiee.org.za
22 - 23	Transformer Design, Protection, Testing And Maintenance	Johannesburg	roberto@saiee.org.za
22 - 25	2018 IEEE 22nd Workshop on Signal and Power Integrity (SPI)	Brest, France	www.ieee.org.za
24 - 25	High Voltage Testing And Measurement	Johannesburg	roberto@saiee.org.za
25 - 26	2018 Power, Energy, Signals and Automation	Chennai, India	www.ieee.org.za
27	2018 IEEE/ACM Symposium on Software Engineering in Africa	Sweden	www.ieee.org.za
29 - 30	Fundamentals of LTE Mobile Communications	Johannesburg	roberto@saiee.org.za
29	2018 Smart Grid and Clean Energy Technologies (ICSGCE)	Malaysia	www.ieee.org

JUNE 2018

3 - 7	2018 Power Modulator and High Voltage Conference (IPMHVC)	Wyoming, USA	www.ieee.org
5 - 7	Fundamentals of Medium Voltage Protection	Johannesburg	roberto@saiee.org.za
6 - 7	Photovoltaic Solar Systems	Johannesburg	roberto@saiee.org.za
10 - 15	2018 IEEE 45th Photovoltaic Specialists Conference (PVSC)	Hilton, USA	www.ieee.org
12 - 13	AfricaRail 2018	Johannesburg	www.terrapin.com
13 - 14	SANS 10142-Part 1 & OHS Act	Johannesburg	roberto@saiee.org.za
13 - 15	2018 IEEE Transportation Electrification Conference and Expo (ITEC)	California, USA	www.ieee.org
19 - 20	Core Financial Management	Johannesburg	roberto@saiee.org.za
20 - 21	Network Frequency Controls	Johannesburg	roberto@saiee.org.za
24 - 27	Water Institute of SA Annual Conference & Expo	Western Cape	www.wisa.org.za
26	2018 PES-IAS PowerAfrica Conference	Western Cape	www.ieee.org
27 - 28	Carrier Ethernet 2.0 Fundamentals	Johannesburg	www.saiee.org.za
27 - 29	2018 15th Conference on the European Energy Market (EEM)	Lodz, Poland	www.ieee.org

JULY 2018

17 - 18	Smart Procurement World Natal	Durban	www.smartprocurementworld.com
17 - 19	PowerGen Africa & DistribuTech	Johannesburg	www.powergenafrica.com

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