



THE FUTURE IS LOOKING UP

The space race is a battle of big minds and miniature satellites. Much remains to be done but outer space could potentially be a trillion-dollar industry that Africa will also cash in on.

BY KAREN MWENDERA

Brittany Bull is only 18 years old but can already add ‘space scientist’ to her resume.

She is part of a team building one of South Africa’s first privately-owned nanosatellites to launch into space.

“The space industry is about exploration and exploration only happens when you do something nobody else has done before,” says Bull, her face lighting up like the moon.

The teenager grew up in a small, sleepy town called Strandfontein in the Western Cape province of South Africa where starry nights are more the norm than satellites.

But Bull has ambitions for herself and the planet.

She is currently studying engineering and is ambassador for a space program at XinaBox, an Internet of Things (IoT) and electronics development solution focused on coding.

The nanosatellites Bull is working on will be released by a rocket at an altitude of approximately 250km, and will travel to the International Space Station (ISS).

“That’s extreme low earth orbit. That’s the first time a satellite is going to fly in that orbit and it’s the first time a satellite that small is going to fly,” she says.

Five nanosatellites “linked together in a thin film of solar panels” will fit in a box similar to a CubeSat (a miniaturized satellite for space research).

Once ejected from the rocket, the box will open up and the five satellites will unfold with a motherboard and radio attached to them. Their function will be to collect temperature data.

“The main purpose of that is to figure out burn-up temperature and rate upon re-entry into the atmosphere from that altitude,” says Bull. “No flight has ever taken place at that altitude before so that is going to be the first.”

It will orbit for 14 days before burning up. The data will be transmitted via radio before that happens.

“It is really awe-inspiring and also motivating because I did not let my background stop me. So what’s to say that every other African child can’t make a valuable contribution and if every other African child is given the opportunity, we would progress so fast...,” she says, smiling.

Bull always dreamed of taking the leap into the space industry but never knew what career path would take her there.

She had wanted to study nursing like many other girls her age in her community but in 2015, when a group of female engineers and astrophysicists came to teach students about STEM (Science, Technology, Engineering and Mathematics), her dreams started coming true, slowly but surely.

The following year, she joined Space Trek, a space science camp in Cape Town offered by Morehead State University in Kentucky, United States (US).

It was a STEM program aimed at empowering young girls. She then applied to their space science and engineering degree program and was accepted on a part-scholarship basis.

Bull is currently raising funds for her stint at Morehead State University and plans to start next year.

Once she is done with her studies, she hopes to return home to make an impact in South Africa’s emerging space industry.

“My dream is to bring that expertise back to South Africa and help make SANSA

[South African National Space Agency] just as great,” she says.

“I feel my biggest contribution would be here.”

Onwards and upwards

South Africa has sent three satellites to space. The first was a miniature satellite launched in the US in 1999, built by post-graduate students at Stellenbosch University in the Western Cape.

The second South African satellite was launched into space by a Russian Soyuz rocket at Baikonur in 2009. It was called the Sumbandila satellite.

“It is a Venda [South African] name for path-finder,” says Nomfuneko Majaja, the Chief Director: Legal & Compliance, SEZs and Space Affairs at the Department of Trade and Industry (DTI).

Majaja is the former member of the Ad hoc Committee for the review of the Space Affairs Act No. 84 of 1993.

She has experience in national economic policy development and strategy processes and specifically in aerospace, outer space and electro-technical sectors.

Majaja says the space industry is not as big compared to other industries in South Africa, and is trying to change that by interacting with various stakeholders involved in the country’s space economy.

But she says the industry is growing significantly.

In 2013, South Africa launched its third satellite, developed by a high school learner in the Eastern Cape province of South Africa.

It was South Africa’s first cube satellite known as TshepisoSat (Code name ZA-CUBE1).

“In conjunction with developing small satellites, there’s now a big move to developing CubeSats,” says Majaja.

A cube satellite is a miniaturized satellite made up of multiples of 10cm×10cm×10cm cubic units. Satellites are getting smaller, smaller, and still smaller.



OVER 40% OF THE SATELLITES LAUNCHED IN AFRICA WERE LAUNCHED OVER THE LAST TWO YEARS.”

– ONIOSUN TEMIDAYO

Euroconsult, a global independent consulting and analyst firm specializing in satellite-enabled vertical markets, predicts that about 7,000 small satellites will be launched, at an average of 580 per year by 2022 and growing to an average of 820 per year by 2027.

“You can put a satellite in your hand, that’s how small it is,” adds Majaja.

Bull is also working on a project with XinaBox to create an even smaller satellite called the X Sat.

“It could fit into an iPhone 7 Plus. It is that tiny,” she says.

It will have different sensors with functions.

“We have an array of sensors for infra-red sensing, ultraviolet light sensing, carbon emissions...”

It will also have GPS sensors.

South Africa is currently working on launching the next CubeSat in December 2018 on a Russian Launcher.

One of the ambitious projects many are looking forward to in the country is the Square Kilometer Array (SKA), an international effort to build the world’s largest radio telescope, with a square



kilometer (one million square meters) of collecting area.

According to their website, it will deploy thousands of radio telescopes, in three unique configurations, and enable astronomers to monitor the sky in unprecedented detail thousands of times faster than any system currently in existence.

“The South African MeerKAT radio telescope is a precursor to the Square Kilometre Array telescope and will be integrated into the mid-frequency component of SKA Phase 1,” they state on their website.

More than 500 international astronomers and 58 from Africa have submitted proposals to work with MeerKAT once it’s completed.

“The space industry in Africa is really going to change completely, because of things like the Square Kilometre Array and MeerKAT and the fact that there are a lot of space-tech companies in Africa and African governments doing satellites,” says Bull.

“Soon, we might have a space agency on the continent that could rival NASA in terms of research, because we are strategically

placed for a lot of research that the people in the US can’t do.

“The space industry is going to move and it is going to change and if we have enough people who are passionate enough about it, then we might just be at the helm of the ship.”

Using space technology to resolve Africa’s problems

Thousands of kilometers away from South Africa, 24-year-old Oniosun Temidayo has made it his life’s mission to make Africa the next frontier of the space industry.

Temidayo grew up in a family of five children in Oyo State in the southwest of Nigeria, but always aspired to go to space. There were no opportunities to study aerospace engineering or astronomy so he studied meteorology instead, but space is his first love, and he has been involved in the industry for the last five to six years.

“The good thing about investing in the space industry is that it helps you solve major societal problems. Space technologies can go a long way in actually helping us solve issues like agriculture or security,” he tells FORBES AFRICA.

When he was only 18, he established

a space club in his university with over 200 members. He was also involved in the university’s center for space research.

In 2017, he was part of the group that created Nigeria’s first nanosatellite in conjunction with the Japanese Birds-1 program, a collaborative effort between the Federal University of Technology, Akure (FUTA), and the National Space Research and Development Agency. It involved five countries, namely Bangladesh, Japan, Mongolia, Ghana and Nigeria. Temidayo worked on the ground station development.

The project’s aim was to equip the future generation of students to create their own satellites.

Post his studies, Temidayo joined the Space Generation Advisory Council, a global organization aiming to bring the views of young space professionals to the United Nations. There, he became the African regional coordinator driving the development of space and promoting STEM.

In 2017, they hosted an African region space generation workshop, a gathering of young space professionals in Africa with 15 countries in attendance.

Early 2018, the young entrepreneur founded a company called Space in Africa, a platform that covers the business, technology, discoveries, events and political news around the African space and satellite industry.

His goal was to put out African-related information about the industry that he found lacking.

“In Africa, we believe it’s actually time to get involved in the space industry. But we realized this is not going to happen if there is no adequate information on the industry,” he says.

He was the only African listed under the 24 Under 24 Leaders and Innovators in STEAM and Space Awards given away by The Mars Generation (a non-profit with boards of leaders from the space industry) early 2018. The list awards young people driving STEM and space globally.

In August, he also made it to the 35 Under

35 in the space industry ranking by the International Institute of Space Commerce (established at the Isle of Man). He was one of two Africans on the list.

Despite the lack of resources the country has in space technology, Temidayo says space technology can help in a much bigger way.

“I remember when the Chibok girls went missing in Nigeria, that’s actually a scenario where space technologies could have been capitalized on. At some point, we were using satellite technologies to track them,” he says.

Temidayo emphasizes on technology.

“The argument shouldn’t be ‘should we invest in space’? Yes, we should invest in space. At the same time, we should have policies that enable us to actually make use of these technologies to solve our problems.”

Africa’s outer space strategy

Despite the many challenges Africa faces, experts say it will not shy away from the space race and many countries on the continent plan to make their name in the sector.

There are currently 13 space agencies listed in Africa and 28 satellites have been launched by African countries so far (owned by Egypt, Algeria, Angola, Morocco, Ghana, Nigeria, South Africa and Kenya).

According to the *Business and Market Analysis of the African Space Industry* done by Space in Africa, over \$3 billion has been spent on space projects in Africa since the launch of NILESAT 101 by Egypt in 1998.

“Over 40% of the satellites launched in Africa were launched over the last two years,” Temidayo says.

“This means that in the past two years, African countries have been investing more in space technologies than they were 10 years back.”

Temidayo expects the trend to continue.

“By the end of this year [2018], four more satellites will be launched by African countries.”

Kenya launched a satellite too in 2018.

Charles Mwangi was involved in the development of Kenya’s first space object



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– BRITTANY BULL

christened 1st Kenya University Nano-Satellite (1KUNS-PF), also a 10cm x 10cm x 10cm cube satellite.

“Kenya is a space-fearing nation,” he says. “Meaning, we have a space object out there; we have joined the space race.”

He is currently the assistant country coordinator for Kenya Space Agency and is pursuing a second master’s degree in the field of space development.

He wants to be a force in the Kenyan space industry and says instead of going to space, his dream is to inspire young people here on earth.

“I want to make an impact so that kids can dream about space as a career,” he says.

He hopes Kenya will be able to maximize the full benefits of the space industry.

“If satellites can be designed, assembled and tested in Kenya, if we can do that, then we can say we are making progress.”

According to the African Union (AU) Agenda 2063, one of the aspirations is to develop the African Outer Space Strategy with plans to establish an African space agency.

In 2017, a framework was developed by the AU on how to fund the agency, draft its goals, benefits and legalities.

“African countries are investing more in space now more than ever, and the trend is actually going way up. We expect it to remain like that,” Bull from South Africa agrees.

“The perception of space is changing; it’s not something for geeks anymore, it’s not something unheard of. A lot of people are starting to take it seriously and they are also starting to be interested in it,” she says.

“So that means there’s going to be more people going into the space industry and contributing, which means we will make progress faster.”

“Seeing that space has a strategic place in enabling the economy, we believe that the government should do that,” Majaja concurs.

This will help governments in strategic planning with the data they receive from satellites.

She says satellites can assist with water sanitation, weather monitoring, ocean monitoring and management, and border monitoring.

“There is room for us to manufacture our own satellites and be able to distribute data,” she says. However, there are big challenges ahead for the continent.

“Most African countries cannot afford to spend on space technologies,” Temidayo says. In additions, he says there aren’t enough educational programs in Africa that support space study.

“African countries have relied on countries like China to build their space technologies,” he says.

“If we want to grow our space industry, we need to start grooming the people who are going to be building the space agencies.”

Training more people in the space industry and STEM is important.

Temidayo says the African space industry is only \$3 billion of the \$400 billion globally. And Nigeria and South Africa have been leading in this space.

While other global countries are planning their next trips to Mars and other planets, Africa still has a long way to go.

“Africa cannot think like that. We have a lot of problems to solve so let’s use space technologies to solve our problems. I don’t think Africa should get involved in such missions. Let’s use space tech to solve our problems first,” says Temidayo.

He adds that more Africans are traveling to developed countries to learn about the space industry and returning to contribute towards it in Africa.

“With the rate at which we are growing, I think the future is bright... My goal is to actually see a booming space industry in Africa,” he says.

“I want to see the first commercial space unicorn in Africa. If I see that, I’m going to be super happy.”

He believes that although Africa may not currently be at the forefront of the space race, more local businesses and startups should be involved.

Global players in another realm

Space is a dark, airless vacuum, full of radiation and unknown microorganisms.

But for some companies, this vacuum can throw up big business possibilities.

Since the mid-20th century, during the cold war, space exploration has seen stiff competition.

Now, it has become easier and less costly to fly to space or send satellites to space.

According to the United Nations Office for Outer Space Affairs (UNOOSA) 2017 annual report, there are approximately 4,600 satellites in the earth’s orbit.

In 2017 alone, there were 553 satellites and other space objects registered.

These were a combination of privately-owned and governmental objects. This is

an increase of 8.91% compared to satellites registered in 2016. The countries with the most satellites in space are Russia, the United States, China, Japan, France and India.

This shows a rising interest in space exploration as scientists keep developing more economical space rockets.

At the moment, Space X is one of the most notable companies making an impact in the space industry.

The big American corporate founded by South African techpreneur, Elon Musk, is known for designing, manufacturing and launching advanced rockets and spacecraft.

In 2012, it became the first privately-owned company to send a spacecraft, known as Dragon, to the ISS to deliver cargo and return to earth.

Since then, there has been an increase in the number of private players looking to the stars.

Morgan Stanley, a multinational investment bank and financial services company, estimates that the global space industry could generate revenue of \$1.1 trillion or more in 2040, up from \$350 billion.

Apart from the exploration of intelligent life forms, investors are looking for out-of-the-world profits.

Billionaire Richard Branson is in the space race and his company Virgin Galactic is hoping to put people in space soon.

“One of our biggest investments has been the space companies, which we have already invested \$1 billion to set up,” he says in FORBES’ 100th anniversary issue in 2017.

Ashes among the stars

One other company invested in the space industry is the Houston-based Celestis. If anything, it has transformed the way memorials are done.

The company has been launching the ashes of loved ones into space since 1997.

It garnered global attention when it dispatched a symbolic portion of the cremated remains of *Star Trek* creator Gene Roddenberry, 1960s icon Timothy Leary,



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– NOMFUNENKO MAJAJA



and 22 other participants into earth's orbit aboard a Pegasus rocket.

Charles Chafer, the CEO of Celestis, co-founded the business in 1994.

"Our job was to put together two of the most conservative industries out there, the space industry and the funeral industry," he tells FORBES AFRICA.

Since then, they have been dominating the memorial space industry and have not looked back.

The ashes are kept in a capsule and transported into space via other rockets traveling there.

The company offers services to launch the capsule into space in a zero gravity environment and then return it to earth.

Another service includes launching the capsule into orbit where it remains until it re-enters the atmosphere.

Lastly, the capsule can also be launched to permanently remain on the moon.

Each capsule has a tracker and transmits the data of its location.

In 2019, the company plans to launch a voyager service that will send the spacecraft carrying the capsules on a permanent journey through space.

Chafer says the space industry offers many avenues for growth.

"We have an opportunity to extend our civilization at large throughout the solar system," he says.

"I see it as an opportunity that's not just economic and cultural, but a human opportunity... It's pretty simple because I think we are starting to see that you cannot have unlimited growth of any kind in a finite system and earth is a finite system," he says.

The company has seen vertical growth.

"We have basically doubled our revenues every year for the last three years," says Chafer.

But there is no guarantee every startup will be successful, he adds.

"The great thing about having different companies is that there will be a lot of good ideas. But by no means will all of them make it... You need a lot for some of the best ones to emerge and become part of that economy."

Chafer believes his business is here to stay, and in the future, he would like his own remains to be sent off to the depths of space too.

The risks at zero gravity

Meir Moalem, a former fighter pilot from Israel, is the CEO and co-founder of Sky and Space Global Ltd.

Growing up, Moalem was a space geek.

"I always considered myself a space junkie. I loved astronomy and read all the science fiction books. So it was very clear to me that when I'd come of age, I would do something that involves physics, astronomy, space or something like that," he says.

Instead, he found himself becoming a jet pilot in the Israeli air force and spent 25 years there. That's also when he decided to acquire a degree in physics and get involved in Israel's space industry.



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– CHARLES CHAFER

When he graduated, he became the manager of an Israeli project that sent an astronaut to space.

In 2003, a friend, Ilan Ramon, was part of a seven-crew member trip to space onboard the space shuttle Columbia. He was Israel's first astronaut.

However, the two-week mission ended in tragedy as the shuttle was destroyed 16 minutes before it landed on earth. All seven crew members died.

"It was also a reminder about how dangerous space is. It is exciting, it is sexy, it invigorates the imagination, it has a huge value but it is also a risky business," Moalem tells FORBES AFRICA.

A quick Google search reveals that there have been 30 recorded fatalities resulting from space flights or testing.

"When people are not involved and when a satellite explodes on a launchpad, we tend to think it's only money, but although lives are not lost, it is not only money. It's people who have invested years of their lives in a mission and were looking forward to see the success of their work being put into that, but it is a risky business," he says.



A Celestis capsule attached to a rocket

NASA and Space.com have estimates that the average space shuttle mission costs between \$450 million and \$1.6 billion.

According to *Business Insider*, one of the most expensive failed space missions lost \$424 million.

This was a NASA launch in 2011.

A satellite worth \$424 million was meant to track the earth's climate but encountered problems when the rocket's nose cone failed to separate.

In developing countries that depend on internationally-owned satellites, that loss also has an impact, says Majaja.

"Imagine just one day, a satellite is switched off and you are unable to do a transaction you want with your financial institution. Imagine all of us in South Africa... our lives will come to an end, the company's lives will come to an end, these economies will come to a standstill," she says.

The failure of satellites can have an enormous ripple effect on the whole world.

Moalem says it is a very difficult and complex business but it's also about innovation.

Despite the major risks involved, his company launched its first satellite in June 2018.

Now, it's planning to launch 200 nanosatellites into orbit in 2019.

"Up until now, when you are working on a commercial space application, it is extremely expensive and you are working for years and years and you have a satellite that costs \$200 million or \$300 million or a rocket that costs \$100 million and God forbid something happens, and you lose years and years of effort," he says.

Moalem is planning to change the risk factors involved in space projects.

"We are actually transforming that and creating a reliable ecosystem," he says.

Instead of launching the 200 satellites at one go, they are launching 20 to 25 satellites every three months so that if something inadvertent were to happen, it would have less of an impact on the business or overall program.

"What we are doing is completely disruptive and it has transformed the capital structure in the space business," he says.

"You don't need hundreds and hundreds of millions of dollars to build a commercial space company. You can do with a lot less and still provide very good services and very good capabilities to your customers.

"We are changing the way we are thinking about it and making the space business or space endeavours more reliable, more trust-worthy," he adds.

He says it is becoming cheaper and the trust factor is in place now because you can contain the risk.

Moalem's business has been able to raise \$35 million in the Australian stock exchange.

Through the 200 nanosatellites, he hopes to improve mobile communication coverage globally by offering a service to internet and data service providers for faster and efficient communication.

No doubt there have been huge leaps in the journeys to space with advancements in communication and technology.

This has also been fueled by entrepreneurship and innovation.

The outer space has become a level playing field, and Africa is ready to lift-off.



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– MEIR MOALEM

A 100 people worldwide have been shortlisted by the Mars One project to travel to Mars in the next decade to establish a human colony. A few Africans, such as Adriana Marais have also made the list. It's a one-way ticket to the Red Planet in 2026. Other South Africans include Alexandra Doyle, Edwin Samuel le Grange and Divashen Govender.

'DON'T BE AFRAID OF FAILURE'

A former NASA astronaut, Charles Bolden, who visited Africa recently, on the importance of STEM education in the development of the space economy.

BY KAREN MWENDERA

Major General Charles Bolden from South Carolina has been in the space industry since the 1980s. During his time as an astronaut, he served as the Administrator of NASA. In this capacity, Bolden oversaw the safe transition from three decades of space shuttle missions to a new era of exploration focused on the full utilization of the International Space Station (ISS), an unprecedented landing on Mars with the Curiosity rover, the launch of a spacecraft to Jupiter, and continued progress toward the 2018 launch of the James Webb Space Telescope (JWST), the successor to the Hubble Space Telescope.

Ahead of his visit to South Africa in November 2018, he spoke to FORBES AFRICA about his work in the space industry.

What does your visit to Africa entail?

My trip involves two countries; Ethiopia and South Africa. This will be my second time here in Ethiopia and my fourth time coming to South Africa... The purpose of coming is actually to try to promote STEM education among the youth and also to talk with business and government leaders about the potential of collaboration with the US in science and technology and also to develop a commercial interest in space.

Where do you think Africa stands in the space industry?

Well, my limited knowledge comes from my time as a NASA administrator; we had five different partners during the time that I was there. South Africa was the dominant partner because they had the most mature space program, but we worked with Morocco, Algeria, and Uganda. And then I had been to Ethiopia before but that was mainly to talk about STEM education and to try to get the Ethiopian government interested in doing some things in space.

I like to remind people that [space] is more than human space land, it's science, it's things like agriculture from space, so in Ethiopia, that's been among the things I got the chance to talk to people about.



With regard to the business side of the space industry, what are some of the projects you see going forward?

I think you are going to see more companies like SpaceX. It is sort of the model for everybody today. They are the most well-known, and in fact, SpaceX is the company that is taking the US from being almost a non-player in launch operations, say 10 years ago, to today actually dominating something in the neighborhood of probably 60% or 70% of launch operations.

With the Chinese being next and maybe Russia being third, but we completely turned the market around such that the US is now a major provider of launch services.

That is not government; that is private launch providers like SpaceX, or even small enterprises. So that is the trend.

It is going to be private and entrepreneurial service providers with the government and big businesses buying the service; whether the business is data or transportation.

How has technology impacted space travel?

Perhaps the biggest change today is the ability of robotic spacecraft to reach other robotic spacecraft and make repairs, whereas before, that could only be done by humans like we did with the Hubble Space Telescope...

When we moved to the ISS, we had migrated to robotic devices; appendages on the outside of the ISS that can be programmed to do a particular task, and there is no human intervention whatsoever once you turn the program on, so we can now use a robot on the ISS to cut and mend cables, hook up fuel lines and electrical cables to different devices. That's the technology development that has given rise to the emerging industry today of on-orbit repair capabilities...

What's your advice for someone who dreams of going to space?

Don't be afraid of failure. Don't let anybody or anything intimidate you into thinking you can't do something.

Just go for it! If you fail, so what? The big thing is getting up and dusting yourself up and trying it again. Those would be my message to young people anywhere. 🚀