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The Chemical Engineer

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SPACE ODYSSEY

From Rocket Engines to Hair Dryers and Back Again

Lolan Naicker explains his unconventional career path to Adam Duckett, from daydreaming in lectures to a £150k win for a lunar water system

IT'S BEEN a wild couple of months for Lolan Naicker. He's seen shadowy evidence that a rocket engine he designed years ago has landed on the Moon and won £150,000 (US\$200,000) for inventing a prototype system that astronauts could use to make water from lunar soil.

What is now his day job – adapting and inventing systems for use beyond Earth – began as idle musings during his chemical engineering studies in South Africa.

“I used to think: how are all these principles applied if you operate on another planet? These distillation columns have terrestrial gravity embedded in the design correlation coefficients. How do you separate that out? How do you work with raw materials on another planet? I was daydreaming about all of this stuff while I was sitting in my lectures.”

But working in the space industry seemed unattainable for a student in a country with no space industry. How could he get

there when it was all happening abroad?

Well, it may have taken 20 years, but Lolan found a way. He's meandered through sectors and roles, yet throughout it all his chemical engineering education has served him well.

“Those core skills in understanding the transformation and processing of matter were applicable almost wherever I went.

“I went to work at a space propulsion company doing rocket engineering design. I treated a chemical propulsion system as a mini process plant, but no one else really thought about it like that. Most people had a mechanical engineering background. I had Perry's [*Chemical Engineer's Handbook*] open next to me using the same correlations. It's the same theory, just applying it to different hardware.”

But it took many years – and degrees – for Lolan to “bend the arc” of his career towards space.

His initial choice to study chemical engineering came very late.

(Left) Firefly's lander Blue Ghost casts its shadow on the surface of the Moon

He didn't know any scientists or engineers, but the country has a prominent chemical and mining sector.

"I guess I got used to the concept of petrochemical plants because I grew up in sight of one on the east coast."

But what South Africa didn't have was student loans. If your parents couldn't pay, you had to find a sponsor.

"I managed to find funding from a petrochemical company called Sasol, based on good school results.

"That's how I ended up in chemical engineering."

PAYING IT BACK

Lolan graduated in 2002 and, under the conditions of Sasol funding his degree, went to work for the company. He started in plant operations and then moved to the construction site of a plant where he got experience of construction, commissioning and startup.

"I was the only engineer from the commissioning team left behind after handover to deal with all the troubleshooting. So, I got a good exposure to how you go about getting a real plant operational and a good insight into all the things that can go wrong with them."

He then worked for the code development group in the company's R&D department, developing custom reactor and distillation models.

After work he would go home and study for an undergraduate degree in physics.

"This was how I began to bend the arc of my career.

"I did that 'part-time' undergraduate degree in three years. It was extremely hectic...But once I graduated, I got a job in South Africa's nuclear industry for a company called Pebble Bed Modular Reactor.

"There's a common scenario in South Africa where you get thrown in the deep end. Because there aren't a lot of engineers around, you get given a lot of responsibility very early in your career. I was given the responsibility of doing the accident analysis for the demonstration power plant. And that was figuring out if things went horribly wrong with the reactor, if it depressurised, how much radioactivity would make its way to the public through all of the safety systems."

In his late 20s Lolan wanted to pursue a postgraduate degree so went to the University of Cape Town to study theoretical physics, specialising in cosmology.

"What followed was a four-year career in the space industry, working on this spacecraft main engine design under a development contract awarded by the European Space Agency. About a month ago, it was used by US company Firefly to land on the Moon.

"There's a shadowy picture of this lander on the surface of the moon with a bell nozzle sticking out at the bottom. That's the engine that started my space career. It took 14 years for it to get from an idea to hardware on the Moon, but that's where I started

my space career."

He's beaming as he shares this celestial highpoint. Yet back in 2011, before the private space industry had really taken off, Lolan found himself disenchanted.

"It was difficult to propose anything really novel and take that through to hardware and flight. I got a bit disillusioned with it. It wasn't the very novel, frontier-pushing industry that I had expected. I found it was even more conservative than the nuclear industry."

HAIR TODAY

The next career change sounds less like a meandering bend and more like a handbrake turn. Lolan quit rocket science for Dyson.

"I went from working on a rocket engine to working on hair dryers and hair straighteners. Both of them are on the market now – the Supersonic hair dryer and the Corrale hair straightener. I spent four years in Dyson's secretive research and development department solving detailed material science problems for power-dense high-temperature heater technology.

"It was an interesting change, going from the low-volume manufacturing, precision engineering approach of the space industry to high-volume manufacturing."

Feeling restless, Lolan began asking himself whether he could draw on his diverse experience to build his own company.

"I started by joining someone else's startup."

Founded out of the University of Bath's chemical engineering department, Naturbeads had developed a membrane-based process to produce biodegradable microspheres as a replacement for primary plastics used in cosmetic products. They had received seed funding to scale up their technology. Lolan was their first engineering hire.

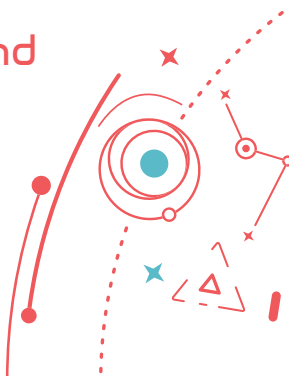
"It was back to chemical engineering for me! I designed, built and commissioned their first pilot plant during the Covid lockdowns.

"At the end of the pandemic, like many others, I was rethinking my life choices. I thought 'I really need to take the risk now'. So, with only a three-month technical consulting contract secured, kids to feed, and a mortgage to pay, I decided to register my own company and see where things would go."

Three-and-a-half years on, Lolan's technical consultancy has been going from contract to contract, designing a wide range of technologies, from household appliances to rocket engines, and growing revenue steadily.

His latest success was winning the £150,000 top prize in the UK Space Agency's Aqualunar Challenge, which Lolan says brings

It took many years – and degrees – for Lolan to "bend the arc" of his career towards space



him back to space “but on my own terms this time, doing innovative things”.

PRODUCING WATER ON THE MOON

The Aqualunar Challenge reminds Lolan of the historical prizes held a century and more ago when prizemoney was offered for achieving a specific goal, before the dominance of the academic grant system.

Among the most influential was arguably the Orteig Prize, launched in 1919 for the first aviator to cross the Atlantic. The prize was eventually won eight years later by a then little-known pilot called Charles Lindbergh. This inspired the most prominent modern equivalent – the XPRIZE – which in 1996 offered US\$10m for the first private company that could launch a crewed spacecraft into space twice within two weeks. Again, it would be eight years before the prize was claimed, this time by aerospace designer Burt Rutan and his company Scaled Composites whose technology was licensed by Richard Branson to create Virgin Galactic.

“It was the first competition I saw that was open to anyone. Many teams competing from around the world, with one winner, and a big pot of money awarded at the end.”

The XPRIZE inspired Lolan at the time, but he wasn’t in a position to enter. In the Aqualunar Challenge, he spotted a second chance.

NASA has set a target to set up a permanent moonbase by the end of the decade and a reliable supply of water is needed for the

astronauts who will live there. In 2024, the £1.2m Aqualunar Challenge was launched to find technologies that could purify water trapped in the lunar surface.

Lolan says: “Imagine digging up the soil in your back garden in the middle of winter and trying to extract frozen water to drink. Now imagine doing it in an environment that is -200°C , a nearly perfect vacuum, under low gravity, and with very little electrical power. That’s what we will have to overcome on the Moon.”

Sounds tough enough, right? Now imagine you’ve got just a matter of days to submit your entry – Lolan only found out about the competition at the 11th hour when a friend emailed him a link.

“I was on holiday with my family. I only had four days left before the submission deadline. The other teams already had three months.

“I had waited for an opportunity like this for a long time, so I wasn’t going to pass it up. I worked like crazy over those four days to research and develop a novel process concept, to create a process flow diagram supported by mass and energy balances, and to explain how and why the concept could work in the harsh conditions of the lunar south pole.”

Lolan submitted it and then gave it little thought. How good could his entry be given he’d started so late?

“I scraped through,” he says, laughing. “I’m not sure I was on top at that point, but at least I managed to get into the ten finalists.”

(Below and top right) Lolan Naicker working on his entry for the Aqualunar challenge



Max Alexander and Aqualunar Challenge

PROVING IT

The teams were each given £30,000 and six months to further develop their initial concepts.

Lolan centred on a process philosophy that would allow for a long operational life by excluding the use of earth-derived consumables such as membranes and reagents. He also wanted to operate continuously to avoid the reliability issues that might stem from cycling equipment under batch production, such as the thermal expansion brought on by heating cycles.

“Continuous-mode operation will allow me to build a plant that could be more easily scaled. If there’s a need for more water production because the lunar base has expanded in the future, the process could be adapted.

“That reduced the design space to certain kinds of technologies which would work under the constraints imposed by the lunar environment.”

Lolan made a conservative assumption about the quality of the feedstock then worked methodically through unit operation concepts that could get him to the 1 litre per minute potable water production goal, before he drilled deeper in the detailed design of the hardware for each unit operation. The competition didn’t require it, but Lolana also built five test rigs to demonstrate the novel aspects of his process to the judging panel.

“There’s only about 5 weight percent of water in the regolith that’s dug up in the south polar region.

“The entire design telescopes down, with a lot of mineral processing right up front and then getting smaller and smaller as one gets to gaseous and then liquid phase water.”

Lolan worked out that using a volumetric heating approach was the most energy efficient way to sublime and extract volatiles trapped in the frozen regolith. He found the magnetron from a store-bought microwave would suffice.

“It worked sufficiently well under defrost mode,” he says. To protect his IP, Lolana is unable to share the full design, but he can offer glimpses. The process is divided into an upstream section operating under vacuum conditions, and a downstream section operating under pressurised conditions. Between these two sections is a secret stage that changes the phase of the extracted volatiles stream from gaseous to liquid. An acoustic treatment method is used to treat contaminated liquid water. Harnessing powerful sound waves, it spontaneously forms millions of tiny bubbles. The extreme temperature and pressure created within each micro-bubble acts as a micro-reactor which effectively degrades contaminants – this gives his Sonochem System its name. It is the first-ever sonochemical process technology proposed for space application.

The broader systems engineering challenges Lolana tackled involved integrating polishing steps, transferring heat between unit operations to reduce power consumption, and recycling off-spec products to maximise yield.

“It’s standard chemical engineering principles, just applied to the operational context of the Moon.”

Echoing his daydreaming of 20 years ago, he even has a small distillation step.

Max Alexander and Aqualunar Challenge



“Back then I was just thinking about it in a qualitative sense. This time I’m actually going into the details.”

The correlations typically used for distillation column design do not directly apply under lunar conditions, as differences in mixing, surface tension, and buoyancy significantly alter the system’s behaviour.

“It turns out conventional distillation columns may need to be much taller than on Earth.”

NAICKER SCIENTIFIC

Lolana is using his prize winnings to grow the company. His victory in March has already attracted interest from larger companies in the space sector. A thermal management aspect of his design is being built for an in-orbit demonstration mission later this year.

Meanwhile, his sonochemical system is likely to find its earliest application on Earth. Lolana has joined forces with his previous employer in Bath to look at how the system could be incorporated into their manufacturing process.

Although chemical engineering has been the foundation of Lolana’s career, he says the varied path he’s taken makes it difficult to define himself or even describe his company – Naicker Scientific.

“I don’t know how to easily summarise my background or my company. I’m still working on a simple one-liner I can say to people at networking events.”

What advice does he have for today’s undergraduates daydreaming about their own unconventional career paths?

“There are no rules for what you can and can’t do with your career. People may try to advise you on the right way to go about building a career but that’s just based on their own strengths, weaknesses and metrics for success.

“I don’t think you get a lot of things for free. It’s a trade-off – you have to make sufficiently large sacrifices to achieve sufficiently large goals. So, I advise them, don’t be afraid to take a unique path, to take risks, to say yes to opportunities which may turn up when you’re not ready for them, and overall, to pursue their own definitions of success.” ■