

The sky's the limit for UKZN rocket scientists

The Aerospace Systems Research Group (ASReG) within the Discipline of Mechanical Engineering at the University of KwaZulu-Natal (UKZN) has two aims: to develop aerospace technologies related to rockets and space vehicles, and to develop human skills in aerospace engineering. Apart from its existing research-based master's and PhD programmes, a module on rocket propulsion for fourth-year engineering students was introduced in 2020.

The ASReG team celebrated a momentous achievement in March, with the launch of the latest version of the Phoenix hybrid rocket. Hybrid rockets are propelled by a combination of solid fuel and liquid oxidiser, and offer advantages over solid motors, such as improved safety and the capacity for throttling.

Hybrid rocket smashes African altitude record

UKZN's much-anticipated Phoenix hybrid rocket test flight at the world-class Denel Overberg Test Range in the Western Cape was a resounding, record-breaking success. The flight took place on 8 March when a gap in the weather provided suitable launch conditions and the Phoenix-1B Mk IIr vehicle soared to a new high-altitude mark for hybrid rockets, beating the previous African record of 10.3 km.

"The team was delighted to see all of their hard work come to fruition with a picture-perfect flight, which exceeded our expectations," said ASReG leader Dr Jean Pitot. ASReG's Phoenix Hybrid Rocket Programme is a skills development initiative that focuses on suborbital launch vehicle design and testing.

"Internationally, sounding rockets continue to play a crucial role in the facilitation of experiments conducted in a wide variety of scientific disciplines, including biotechnology, astronomy, astrophysics, materials science and meteorology, among many others," explained academic leader for mechanical engineering at UKZN, Professor Michael Brooks. "They also serve as valuable test platforms for aerospace technologies related to commercial satellite launch vehicles."



The ASReG team at the Denel Overberg Test Range, near Arniston in the Western Cape.



The Phoenix-1B Mk IIr rocket blasts off.

After signing the fins of the Phoenix-1B Mk IIr pre-launch – a tradition in rocketry research – the team retreated to a mission control blockhouse from where the nerve-wracking countdown started. At 4.47 p.m. Mk IIr blasted off – and the exultant team broke into cheers as the rocket reached an altitude of 17.9 km, setting a new African record.

Said Pitot: "The Mk IIr rocket is a high-performance version of our initial Mk I rocket, and demonstrates low-cost and robust construction methodologies, coupled with advanced fabrication and propellant technologies."

Brooks acknowledged substantial funding received from the Department of Science and Innovation (DSI) for the project. "This funding has enabled the development of key expertise in the engineering disciplines of rocket propulsion technology, launch vehicle design and flight dynamics modelling as well as the development of appreciable scarce skills. It has also enabled unique cooperation between the University and industry," he said.

The ASReG team included 18 postgraduate and undergraduate students who contributed to the success of the launch through their innovative research. These students are products of ASReG's DSI-funded transformation-centred talent pipeline programme.

Lead engineer on the Phoenix campaign was UKZN PhD student Kai Broughton, a winner of the prestigious Engineering Council of South Africa (ECSA) merit medal and a *cum laude* UKZN MSc Mechanical Engineering graduate who has been named among the African Space Industry's 'Top 10 Under 30s' by the Space in Africa news agency.

Written by Dr Sally Frost, public relations manager for UKZN's College of Agriculture, Engineering and Science, and republished from NdabaOnline Vol 9 (7).

Watch a video about the launch at <https://engineering.ukzn.ac.za/news/weflyrockets/>

Propelling Africa's rocket systems forward

The Aerospace Systems Research Group (ASReG) at UKZN is developing the talent of the next generation of rocket scientists to drive South Africa's space industry forward.

Master's candidate Thabang Mdhului, from the village of Phiring in the Limpopo Province, is one of those furthering the mission of ASReG through his research on developing an injector test rig for gelled propellants, supported by a bursary from the Department of Science and Innovation. This rig will be used to visualise and quantify flow characteristics of several gelled propellant analogues – important work as gelled propellants are increasingly being applied to rocket and ramjet propulsion systems, and offer advantages over conventional liquid and solid fuel variants.

Mdhului said gelled propellants will enhance the performance of future propulsion systems and provide improved handling and storage safety. His work will aid in obtaining useful quantitative and qualitative data to facilitate an optimum injector design for a flight vehicle using gelled propellants.

An early fascination with the workings of vehicle engines was helped along by an introduction to the fundamentals and principles of mechanical engineering through his diesel mechanic brother's textbooks. Taking engineering graphics and design as a subject in high school further developed Mdhului's interest.

While Mdhului acknowledges that the intensive mathematics necessary for engineering makes it daunting, he finds its principles straightforward. Although it requires higher-order thinking and the retention and understanding of intricate concepts and ideas, translating the science into engineering and producing designs is where the challenge ultimately lies.

Aiming for a career where he could work through the engineering process from design to development and assembly, Mdhului enrolled for his degree in mechanical engineering at UKZN. His interest in rocket science and propulsion systems was stimulated in his second year when meeting postgraduate students in ASReG who were presenting one of the Phoenix sounding rockets at the annual mechanical engineering Open Day. This led to him enrolling for a master's with the group after completing his undergraduate degree in the minimum time, with four certificates of merit to his name.

His final-year group design project involved designing a pressure vessel for a water rocket demonstration kit for use in explaining rocketry principles to high school learners and encouraging an interest in science, technology, engineering, and mathematics (STEM).



Thabang Mdhului with a one-half scale model of the rocket payload fairing of a commercial launch vehicle being designed by ASReG.

Mdhului advised high school students interested in rocket science to work hard at their STEM subjects and to try and gain understanding of the applications of their work, while also seeking out more information about the industry and participating in as many additional engineering education programmes as possible.

The work he put in over his four-year degree has been a source of pride for his family, and the demanding course with its considerable workload required focused commitment, discipline and strict time management from Mdhului – a keen rugby player who still looks for time on the pitch to balance his physical and academic activities.

"ASReG helped me see that conducting research on aerospace systems, while it seemed far-fetched, was attainable for me," said Mdhului. "I hope that the work we do will one day add South Africa to the list of countries excelling in space activities and help it develop its own launch capability."

Mdhului was recently awarded a scholarship through the Department of Higher Education and Training's Nurturing Emerging Scholars Programme (NESP). He will receive mentorship with a view to moving into academia once he completes his master's degree at UKZN.

Written by Christine Cuénod, journalist for UKZN's College of Agriculture, Engineering and Science, and republished from NdabaOnline Vol 9 (4).

Read the UKZN Newsletter, NdabaOnline, at <https://ukzn.ac.za/media-publications-reports/ukzn-ndabaonline/>

Find out more about the Aerospace Systems Research Group (ASReG) at <http://aerospace.ukzn.ac.za/>

Academy of Science of South Africa (ASSAf)

ASSAf Research Repository

<http://research.assaf.org.za/>

A. Academy of Science of South Africa (ASSAf) Publications

D. Quest: Science for South Africa

2021

Quest Volume 17 Number 2 2021

Academy of Science of South Africa (ASSAf)

Academy of Science of South Africa (ASSAf)

Cite: Academy of Science of South Africa (ASSAf), (2021). Quest: Science for South Africa, 17(2). [Online] Available at: <http://hdl.handle.net/20.500.11911/191>

<http://hdl.handle.net/20.500.11911/191>

Downloaded from ASSAf Research Repository, Academy of Science of South Africa (ASSAf)