

NELSON MANDELA UNIVERSITY

iDEATE

A publication of the Faculty of Engineering,
the Built Environment and Technology

Issue 3, 2023



Pursuing Sustainable Futures
for a Better World

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We are Nelson Mandela University

We are **Nelson Mandela University**.

We are the only university in the world to be named after Nelson Mandela.

Our iconic South African statesman, humanitarian and leader is known globally for what he achieved.

We are honoured as **Nelson Mandela University** to carry his name.

In return, we honour our namesake by endeavouring to live his legacy.

We honour him by using his name in full.

We are Nelson Mandela University.

FOREWORD

Building a more resilient future

In a world facing unprecedented challenges, where the consequences of our actions are felt not only by us but by generations to come, there is a need for us to align our learning and teaching, research, innovations, engagement and activities towards a more sustainable future.

The transformative vision of the United Nations Sustainable Development Goals (SDGs) unites humanity under a common purpose to build a more just, equitable and environmentally responsible world.

As the world, Africa as a continent and South Africa as a country grapple with complex issues of poverty, unemployment, inequality and climate change, the SDGs serve as a guiding framework for a holistic approach towards solving these challenges.

Within this framework lie 17 interconnected development goals, each designed to address specifically identified areas of concern. They not only advocate for social, economic and environmental progress but also promote innovation, collaboration and inclusivity in pursuit of a better future.

Following the first volume of *iDEATE* in 2021, *Entities in Service of Society*, and the second volume in 2022, *Professors and Associate Professors in the Faculty*, it is with great pleasure and enthusiasm that I present *iDEATE* volume 3 for 2023. This issue, on the theme *Pursuing Sustainable Futures for a Better World*, has a few examples of the excellent work produced by our own staff and students in partnership and collaboration with a range of external stakeholders and collaborators, to whom we are extremely grateful.

This year's issue provides invaluable insight into how the research, innovation and engagement within the faculty attempt to address global, national, regional and local challenges. Each project outlines which of these challenges they are tackling and showcases the project's initiatives and innovations in response, demonstrating tangible progress and impact. The faculty's work demonstrates the interconnectedness of the SDGs, emphasising the

importance of a more integrated inter-, multi-, and trans-disciplinary approach to overcoming the challenges humanity faces. It also emphasises the role of technology, education and the active involvement of all citizens in creating lasting change. Moreover, it demonstrates the need for responsible and ethical governance and for leaders to act.

The work highlighted in this issue purposefully aligns with the faculty's recently adopted strategic research focus areas of:

- Advanced manufacturing
- Cyber security and privacy
- Humanising innovation and the digital economy
- Indigenous knowledge systems and sustainable development
- Marine and maritime engineering, technology and sciences
- STEAM education and pedagogies for the digital economy
- Sustainable environments and Infrastructure

As you flip through the pages, be inspired and motivated to join hands with us in making a positive impact: embracing collective responsibility, safeguarding our planet, eradicating poverty, reducing unemployment, promoting equality and ensuring prosperity for all. Together we can create life-changing opportunities, with a promising future for the next generations to come.

I extend my heartfelt gratitude to the leaders of the entities, schools, departments and projects, and all the contributors who collectively shared their knowledge, innovations, project successes and progress in this issue. May their efforts resonate with our readers while empowering and inspiring them to become catalysts for change and champions in service of society.

Professor Marshall Sheldon

Executive Dean: Engineering, the Built Environment and Technology



About Professor Sheldon

Prof Sheldon has a doctoral degree in chemical engineering, combined with a bachelor's degree in business administration. She has more than 24 years' experience in higher education, of which more than 10 years have been in management positions, including five years in senior and executive management. She is a registered with the Engineering Council of South Africa and is member of the South African Institution of Chemical Engineers, the Water Institute of Southern Africa, the South African Society for Engineering, and the Global Engineering Dean's Council (GEDC). She currently serves on the GEDC Diversity Awards panel.

Prof Sheldon is a National Research Fund C2-rated researcher and her area of research is membrane technology and membrane bioreactor systems for wastewater treatment and resource recovery.

Entity: Marine Robotics Unit

Project leader: Andrew Young

Project team members: Elbert Liebenberg,
Jabulile Dhlamini, Joshua Doubell

SDGs

1: End Poverty

2: Zero Hunger

3: Good Health and Well-being

14: Life Below Water



Andrew Young

Marine Robotics Unit trains students for the “Blue Economy”

The marine robotics autonomous surface vehicle project run by eNtsa’s Marine Robotics Unit aims to support the mandate of the South African International Maritime Institute. This includes promoting South Africa’s maritime sector through education, technology transfer, training and research and development.

Marine Robotics project leader Andrew Young, supported by Elbert Liebenberg, Jabulile Dhlamini and Joshua Doubell, has been using the autonomous surface vessel project to provide training opportunities that include both hand skills and advanced manufacturing experience.

The internship students have taken responsibility for the manufacturing, using composites, some of the design work, and the electrical installation.

The process of developing ocean gliders – as these vehicles are popularly known – has proven that autonomous systems equipped with sensors can provide data from challenging and remote environments.

“By investing in the development of autonomous marine systems, we stand to enhance our decision-making with respect to our food security while assuring employment for those in the ‘Blue Economy’,” says Young.

The goals of the Marine Robotics Unit include developing assets and instruments to help predict ocean health

and measure the events that can lead to food security challenges.

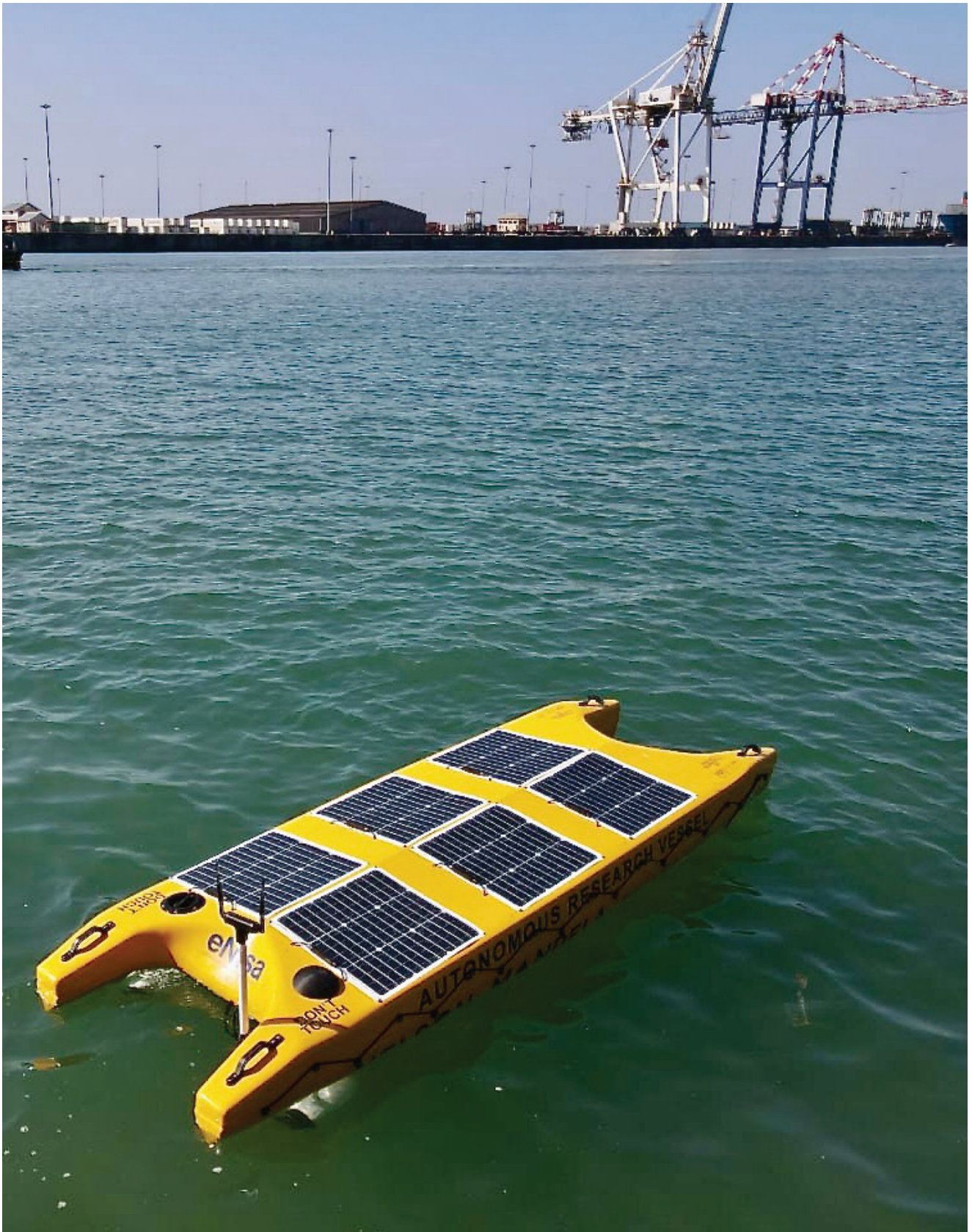
Researching the Indian Ocean

The Western Indian Ocean is the least researched oceanic region on Earth, but provides millions of people with food and employment. The Indian Ocean is changing, with more frequent and intense tropical cyclones as well as changes in biochemistry, resulting in changes to the ecosystem. This, in turn, leads to a significant decline in primary food productivity.

The joint strengths of various institutions as well as the development of advanced technologies, sensors and robotics instruments will be needed to address these challenges.

Collaborative projects are planned with internal stakeholders such as Ocean Sciences at Nelson Mandela University, other African institutions, for example, the Bazaruto Center for Scientific Studies in Mozambique, as well as European and American universities, such as Montpellier in France and Rutgers in the United States.

The marine robotics project will also leave a legacy of assets for marine research. In addition to exposing undergraduate students to advanced technologies, the project will help to develop postgraduate students who have contributed to the pool of new knowledge and developed skill in autonomous systems.



The autonomous surface vessel was used for surveying in Gqeberha's harbour

Entity: Advanced Mechatronic Technology Centre

Project leader: Professor Russell Phillips, Karl du Preez

Project team members: Jan Henrik de Jongh, Damian Mooney, Meera Naidoo, Lizl Blom

SDGs

4: Quality Education

7: Affordable and Clean Energy

9: Industry, Innovation and Infrastructure

11: Sustainable Cities and Communities



Karl du Preez and Professor Russell Phillips

Harnessing the power of the sun

The Advanced Mechatronic Technology Centre (AMTC), in collaboration with the merSETA, introduced a solar boat race in March 2023 to showcase renewable energy and the technology behind it. It also was an opportunity to promote sustainability and encourage innovation.

Teams of learners from six technical high schools and two TVET colleges used solar power to propel boats they had built around North End Lake in Gqeberha.

Project leaders Professor Russell Philips, who heads the Renewable Energy Research Group, and AMTC director Karl du Preez were assisted by team members Jan Hendrik de Jongh, Damian Mooney, Meera Naidoo and Lizl Blom.

The University provided each team with the hardware needed to design and manufacture the solar boat, including two photovoltaic panels, a 12V outboard motor and components for building the boat.

AMTC technologist Jan Hendrik de Jongh conducted training sessions at the schools and colleges to ensure manufacturing and safety standards were met.

The main race consisted of navigating around a marked-out course on the lake, with pilots swapping every half-hour. The winner was the crew covering the most distance in a three hour time span.

The participants were: Newton, Gelvandale and Otto du Plessis technical high schools and PE TVET College

(Gqeberha); Daniel Pienaar and McCarthy technical high schools and EC Midlands TVET College (Kariega), and Port Rex Technical High School (East London).

Students from the University's Department of Electrical Engineering also designed and manufactured a boat for the race. Their boat won but, as they were excluded from prizes, the winning team was the next crew in, from Port Rex Technical High School in East London

"Participating in a solar boat race provides students and learners with a unique learning experience. They can learn about solar energy, engineering, design and teamwork," says Du Preez.

"Students develop problem-solving skills as they overcome challenges that arise during the race."

The event also highlighted a commitment to sustainability and renewable energy, encouraging students and learners to think about their impact on the environment and how they can live in a more sustainable manner.

The solar boat race also provided opportunities to connect with other schools, organisations and businesses that share a similar interest in renewable energy. The event has led to various partnerships with local industries.

A second solar boat race is planned for December 2023, with the aim of increasing participation to 20 solar boats.



Department: Architecture

Project leader: Dr Magda Minguzzi

Project team members: Lucy Vosloo, Dr Yolanda Navarro, Gaos Margaret Coetzee, Gaob Thomas Augustus, Gaob Daantjie Japhta, Gaob Brato Malgas, Chief Xam ≠ Gaob Maleiba, Paramount Chief Gert Cornelius Steenkamp, Chief Wallace Williams, Gaos Anne Williams, Frances Baxter

SDGs

4: Quality Education

7: Affordable and Clean Energy

11: Sustainable Cities and Communities

13: Climate Action

17: Partnerships for the Goals



Dr Magda Minguzzi

Building up knowledge of indigenous architecture

A School of Architecture investigation into the First Indigenous Peoples of South Africa's built environment is constructing a written and digital repository of the technologies and techniques used by these communities.

Architecture senior lecturer Dr Magda Minguzzi led a team of contributors from within and outside the School of Architecture, while Gaos Margaret Coetzee headed the First Indigenous Peoples' representation, which included members of the Gamtobaqua, Inqua Camdeboo, Inqua, Damasonqua, Oeswana and Gamtours Gamktwa tribes.

The research project is the result of a communal effort and successful partnership with the First Indigenous Peoples leaders and community members in the Nelson Mandela Bay Municipality and vicinity.

It was piloted in 2021 and continued in 2022 and 2023 in the Baviaanskloof, a remote area of the Eastern Cape where the built environment has not been studied.

The aim is to document and promote awareness of the First Indigenous Peoples of South Africa's tangible and intangible heritage in relation to settlements and dwellings that have been self-built with local materials.

These dwellings – some older than 100 years – represent a unique case, as the indigenous building

knowledge, typology, technique and materials have been handed down orally from precolonial times till the present.

Three key factors make this project and these dwellings unique, according to Dr Minguzzi:

- **Isolation:** the dwellings are in an area that is not easy to reach due to its geography, and thus the inhabitants' lifestyle was not drastically influenced by the arrival of the settler colonialists.
- **Permanent continuity:** the indigenous peoples have been there since precolonial times and did not experience the apartheid forced removals seen in the rest of the country.
- **Common land, self-built:** the dwellings are on common land owned by the indigenous community, and they have been able to build using materials collected locally, such as bamboo, reeds and mud.

This has been the first opportunity for the KhoiSan community of the Eastern Cape to document these indigenous knowledge systems as they relate to their built environment.

It is particularly important due to the fragility of the dwellings, lack of regular maintenance and loss of know-how. They are a unique example in South Africa.



Additionally, this research engagement promotes the transmission of cultural values and a history that cannot be found in books. It enhances recognition of the sociocultural and socio-economic sustainability of these dwellings and techniques, which will ultimately promote social cohesion.

Furthermore, the study is particularly relevant to the global environmental crisis, as it is a model of a self-sufficient lifestyle and regenerative approach to the environment and resources. The research group envisions this being applied

to alleviating poverty and promoting food security in other parts of the country.

"In 2023 we produced a documentary entitled *Indigenous Architecture of Zaaimanshoek in Baviaanskloof*," says Dr Minguzzi.

She continues, "The next development will be to use the completed research in a book, or manual, of the indigenous knowledge systems of the built environment of the First Indigenous Peoples of South Africa in the Eastern Cape."

Entity: Southern Africa Cisco Academy Support Centre

Project leader: Gratitude Kudyachete

Project team members: Shaun Vincent, Kevin Kativu, Charmaine van der Haar, Gantsho Chuma

SDGS

4: Quality Education

8: Decent Work and Economic Growth



Unemployed youths learn digital skills

The Southern Africa Cisco Academy Support Centre (SACASC) is an entity that executes the Cisco Academy Programme as a partnership between Nelson Mandela University and Cisco Systems, a multinational digital communications technology corporation. The programme is taught in more than 10 000 educational institutions worldwide.

Project leader Gratitude Kudyachete and a team comprising Shaun Vincent, Kevin Kativu, Charmaine van der Haar and Gantsho Chuma run SACASC in the School of Information Technology.

In a bid to empower unemployed youths in the Eastern Cape with digital skills that will help the nation thrive in the Fourth Industrial Revolution (4IR), the MICT SETA awarded Nelson Mandela University three discretionary training grants.

The grants were worth R2.77 million and were for 55 learners in the following programmes:

- Internet of Things (20 learners)
- Cyber security operations (15 learners)
- Cisco Certified Network Associate (Computer Networks) (20 learners).

The young people recruited came from disadvantaged backgrounds and the group comprised unemployed matriculants, college graduates and a few learners who had a light workload in their final semester of study.

The trainees started on 1 October 2022 and completed their training in March 2023.

Kudyachete said support centre instructors trained the students, and exposed them to state-of-the-art laboratories equipped with Cisco networking and security equipment.

They were also provided with work placement opportunities with a local information and communication technology (ICT) infrastructure-building and system integration company.

Each programme had up to three courses. Those who completed the courses were awarded course completion certificates. The pass rates were:

- Internet of Things: 98%
- Cyber Security operations: 95%
- Cisco Certified Network Associate: 50%

Participants gave feedback that highlighted the benefits of the courses:

"It's a great initiative which allows some of us who could not afford to further their studies the chance to do exactly that, and gain new knowledge that can make us competitive in the IT job market."

"It is a very educational programme that prepares us for the work environment."

"I feel so honoured to be part of the programme, I gained new skills and also got an opportunity to enhance the skills I had prior the programme."



Cisco Academy Regional Manager for Middle East and Africa Ahmed Elkabbany, left, congratulates Gratitude Kudyachete

Entity: Chair for Human Settlements, Building and Human Settlement Development

Project leader: Professor Sijekula Mbanga

Project team members: Emma Ayesu-Koranteng, Yonela Mashalaba, Emmanuel Kabundu, Purity Hamunakwadi, Janine Holmes, Noluthando Vithi-Masiza (Ndlambe Municipality), Mark Napier, Coralie van Reenen, Lorato Motsatsi (CSIR), Tshiphiri Tshivhasa, Ntombonina Siwisa, Nomboniso Ketledas (ECDOHS), Ephraim Phalafala, Tshepang Mosiea (DSI)

SDGs

- 2: Zero Hunger
- 6: Clean Water and Sanitation
- 7: Affordable and Clean Energy
- 8: Decent Work and Economic Growth
- 9: Industry, Innovation and Infrastructure
- 10: Reduced Inequalities
- 11: Sustainable Cities and Communities
- 12: Responsible Consumption and Production
- 17: Partnerships for the Goals



Professor Sijekula Mbanga

Strong presence at green building research conference in Ghana

The University's Chair for Human Settlements plays a prominent role in the South African national government's efforts to fast-track its 10-Year Roadmap on Science, Technology and Innovations for Sustainable Human Settlements.

This was highlighted in the University's participation in the second Green Building Research Conference, held at the University of Ghana, in Accra, in July 2023.

The Chair for Human Settlements, Prof Sijekula Mbanga, facilitated the participation of the South African delegation at the conference.

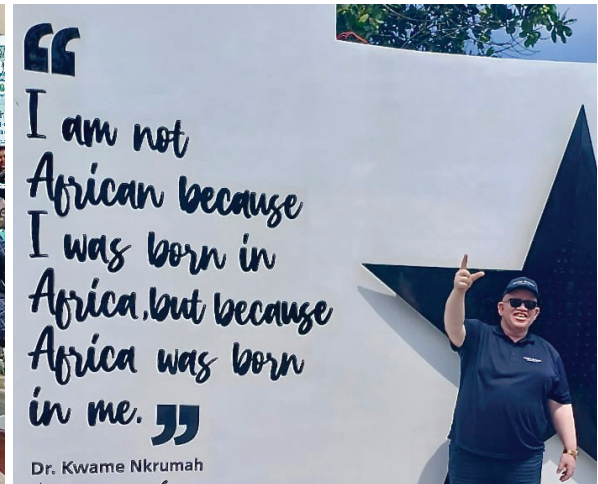
This included representatives of the Department of Science and Innovation (DSI), the Council for Scientific and Industrial Research (CSIR), the National Home Builders Registration Council (NHBRC), the national and Eastern Cape Department of Human Settlements, the Green Building

Council South Africa, and Ndlambe Local Municipality in the Eastern Cape. Representatives of the universities of Johannesburg and South Africa also attended.

The conference spotlighted the roadmap as a strategic transformative framework designed to influence planning, coordination and decision-making in the human settlements sector. This aims to upscale the adoption of innovations and technologies in the home-building industry.

The Chair provided thought leadership in implementing this roadmap by convening a CSIR Programme Management Unit Cluster on innovation at the conference.

The South African delegation visited the Ghanaian Ministry of Works and Housing and the Ministry of Environment, Science and Technology, where the two countries' climate action plans were shared. The group also visited green building and affordable housing innovation sites around Accra.



Clockwise from left: Dr Emmanuel Kabundu, centre, moderates a robust discussion between Ghana built-environment researchers and practitioners and Prof Sijekula Mbanga, right. Prof Sijekula Mbanga acknowledges a well-known quote by Dr Kwame Nkrumah, Ghana's first Prime Minister and President. Delegates from South Africa at the conference in Accra.

The conference included keynote speeches by policymakers, practitioners and academics, academic papers and moderated round-table discussions.

Among the presentations, Ndlambe Municipality Infrastructure Planning and Development director Dr Noluthando Vithi-Masiza used the case of Ndlambe EcoSUN Green Village in the Eastern Cape as a model of green settlements in South Africa.

Dr Vithi-Masiza graduated with her PhD in Construction Management at Nelson Mandela University in 2022, and a book produced from her PhD thesis has since been published.

The conference provided a platform for knowledge exchange, networking, collaboration and capacity building among researchers and practitioners in the built environment, housing and renewable energy spaces.

It was geared to advance knowledge and understanding of green building practices and promote sustainable development in the built environment. This is particularly significant in view of the increasingly undesirable effects of climate change in Africa.

Nelson Mandela University will host the third Green Building Research Conference in July 2025.

Entity: Women in Engineering Leadership Association

Project leader: Professor Ann Lourens

Project team member: Nicole Truter

SDGs

4: Quality Education

5: Gender Equality and Women's Empowerment

8: Decent Work and Economic Growth



Nicole Truter and Professor Ann Lourens

Gender equity: women as role models

The Women in Engineering Leadership Association (WELA) in the School of Engineering has developed three publications to showcase women role models in this field.

"The underlying premise of WELA is to improve the feelings of self-efficacy of women engineering students," says project leader Professor Ann Lourens.

Self-efficacy can be defined as an individual's belief in their capability to plan and take action to achieve a particular outcome.

Its main sources include:

- Mastery experiences, for example, having a positive experience in completing a course
- Social persuasion, for example, social support and mentors
- Vicarious experiences, for example, the visibility of women in engineering fields

Lourens said research had found that women, to a greater degree than men, considered supportive people, including role models, as being important to feelings of self-efficacy.

It also had shown that women valued persuasion in the form of direct encouragement and vicarious experiences, such as seeing another woman succeeding, as critical to their self-efficacy beliefs. In comparison, men tended to value mastery experiences.

Given the importance of role models, therefore, WELA has over the years developed three specific publications to encourage the visibility of women in engineering.

Inspirational Women

Every year, WELA publishes *Inspirational Women*, a booklet showcasing women from various walks of life and demographics who are employed in conventionally male-dominated fields.

Inspirational Students

WELA also publishes an *Inspirational Students* booklet, showcasing junior WELA members. This is to show other young women that they can apply for, and make a success of, engineering studies by seeing young women just like themselves who have done so.

WELA Story Book

The WELA Story Book is a new publication of short stories in which WELA members have written about themselves when they were little girls, to encourage other girls to think about studying in the field of engineering.

"WELA is excited to announce that future *Inspirational Student* publications and the *WELA Story Book* will be published in English as well as isiXhosa," said Prof Lourens.

WELA is funded by the merSETA.



WELA Story Book artwork

Entity/Department: AIDC-EC Chair of Automotive Engineering,
School of Engineering

Project leader: Martin Sanne

SDGs

Goal 4: Quality Education

Goal 8: Decent Work and Economic Growth

Goal 9: Industry, Innovation and Infrastructure

Goal 11: Sustainable Cities and Communities

Goal 12: Responsible Consumption and Production

Goal 15: Life on Land

Goal 17: Partnerships for the Goals



Martin Sanne

New Chair will focus on automotive engineering

Nelson Mandela University and the AIDC-EC have together launched the Chair in Automotive Engineering, supporting South Africa's engineering and manufacturing sector with a specific focus on the automotive industry.

At the launch in June 2023, AIDC-EC Chair of Automotive Engineering incumbent Martin Sanne outlined the role of the Chair:

"Embracing the rapid technological advancements of the Fourth Industrial Revolution (4IR) and Industry 4.0 is essential to stay ahead and prevent industries from becoming obsolete.

"Furthermore, contrary to fears of job losses, studies show that this transformation can stimulate net job growth and improve overall quality of life," he said.

Sanne explains, "Our mission is to empower students to find exciting careers in manufacturing, particularly in electric vehicles and associated technologies, ranging from software systems to additive manufacturing.

"Strengthened partnerships with industry will enhance the curriculum to ensure graduates meet the demands of the sector and have long-term careers ahead of them.

"To focus on and align with industry requirements, the aim is to establish engineering research and innovation platforms covering software systems, manufacturing and

digital industries, smart factories, advanced materials, product development and robotics."

These platforms within the Chair will include:

1. Software systems addressing, for example, the "fully connected" car, where software defined vehicles include data-based platforms for all areas of life, logistics, accommodation, entertainment and open ecosystems;
2. Manufacturing and digital industry platforms, with digital design and services provision added to products and manufacturing environments;
3. Smart factory platforms, incorporating technologies such as 3D printing, advanced materials, advanced robotics, human enhancement, the Internet of Things and artificial intelligence;
4. An advanced materials and engineering research and innovation platform aimed at parts and assemblies fabrication, metal injection moulding, investment casting, high pressure die casting and additive manufacturing;
5. Product development platform (E2E, OEM) using digital product life-cycle management, digital twins and digital threads; and
6. A robotics and future production platform for automation, digitalisation, machine learning, human machine collaboration, and design of future production systems.

It is envisaged that these platforms will lead to exciting projects in the future.



Above: Dr Thandi Mgwebi, left, Martin Sanne and Professor Marshall Sheldon celebrate the launch of the AIDC-EC Chair of Automotive Engineering

Entity/Department: Centre for Community Technology

Project leader: Professor Darelle van Greunen

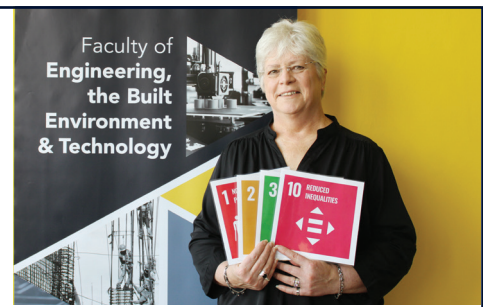
SDGs

1: End Poverty

2: Zero Hunger

12: Responsible Consumption and Production

13: Climate Action



Professor Darelle van Greunen

LEAP-Agri supports small-scale farmers achieve SDGs

Feeding the world's population in an environmentally and socially sustainable way is a major challenge for the future.

Development of small-scale agriculture has an impact on four of the UN's Sustainable Development Goals (SDGs), namely eradicating poverty (SDG1), eradicating hunger (SDG2), promoting sustainable consumption and production (SDG12), and taking urgent action to combat climate change and its impacts (SDG13) – all key focus areas for the Centre of Community Technologies (CCT).

LEAP-Agri – an EU–Africa research partnership on food and nutrition security and sustainable agriculture – is supporting an ICT-based solution that assists small-scale farmers in marginalised communities to achieve these SDGs. The ICT project was developed by the CCT in partnership with Fraunhofer Portugal, a European non-profit research association.

The mobile application aims to assist rural farmers to increase soil quality and yield capacity, initially focusing on maize and sweet potato crops. It has a real-time weather application, a soil classification triangle and pest control modules with colour images that will help farmers to identify and treat certain pests.

The project also aims to teach and educate farmers about soil and crop management by using sensor data collected via an Internet of Things (IoT)-based sensing box. This will measure soil and environmental parameters such as soil pH, soil moisture, temperature and atmospheric humidity.

The app is capable of transmitting data over Wi-Fi, Bluetooth, radio frequency and SMS. The soil conditions

monitoring system displays the information on a smartphone and is then sent to farmers' soil management applications.

The CCT is responsible for configuring the sensor box and developing the sensor application and mobile soil application.

Implementing this LEAP-Agri project can potentially enhance small-scale farmers' traditional knowledge and techniques, increasing their adaptive capacity and resilience towards the effects of climate change.

CCT Director Distinguished Professor Darelle van Greunen says her team started out by developing liquid fertilisation plants for South Africa.

"However, we decided that perhaps this was not the way for us and for the continent to go because most small-scale farmers still use manure," she says.

"We suggested that instead we look at climate change, soil management and soil sensors, as we are focusing on small-scale farmers, particularly crop farmers, to start with."

The CCT tested the first version of the sensor box developed by Portugal and customised this for Africa.

The box has now been 3D-printed with all the different sensors, and sensor readings have been done across South Africa, Zimbabwe and Mauritius. Prof Van Greunen says that they are fine-tuning the app that works with the box.

The National Research Foundation has funded the development of the sensor box.



Entity/Department: Centre for Community Technology

Project leader: Professor Darelle van Greunen

SDGs

3: Good Health and Well-Being

9: Industry, Innovation and Infrastructure

17: Partnerships for the Goals



Professor Darelle van Greunen

Health apps target cancer management and care

The Centre for Community Technologies has forged partnerships with leading health organisations, nationally and internationally, to develop an array of mobile health solutions, some of which are geared towards managing cancer-related pain.

CANSA Pain Manager

In 2022, the Cancer Association of South Africa (CANSA), in association with the CCT under the leadership of Distinguished Professor Darelle van Greunen, launched the CANSA Pain Manager application.

Sponsored by Pfizer, the app was developed to assist the patient and caregiver in understanding pain better.

The app gives information on how to cope with challenges linked to pain and stress levels. It is in a diary or calendar format, where the patient or caregiver inputs relevant information such as logging pain, where it is felt and its intensity each day.

The CANSA Pain Manager app can be downloaded, free, on Android and iOS devices.

C-VIVE

The CCT, OutSystems (a global leader in low-code application development) and NTT DATA (one of the world's largest IT services companies), have created an app to promote cancer awareness through technology within rural communities in South Africa.

Realising the prevalence of certain types of cancer in the Eastern Cape, the CCT developed a technology solution, C-VIVE, to create awareness about cancer. It also focuses on

prevention, especially among people who do not regularly have access to cancer information.

C-VIVE won the 2022 OutSystems Innovation Award for Social Impact, standing out for its cultural inclusiveness, multilingualism (the app supports isiXhosa, isiZulu and Afrikaans as well as English), gamification, accessibility, animations and the functionality of the content, which is accessible in offline mode.

C-VIVE can be downloaded, free, from the Google Play Store and will soon be available in iOS.

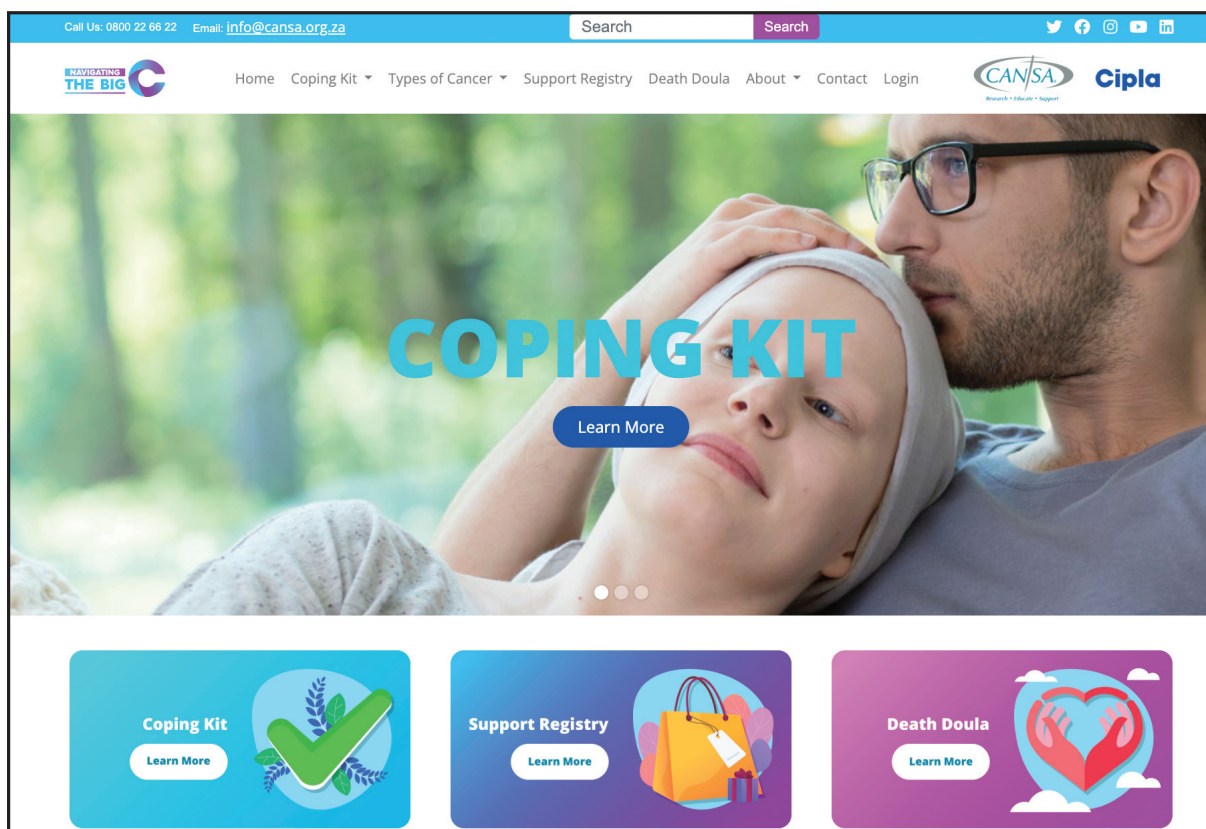
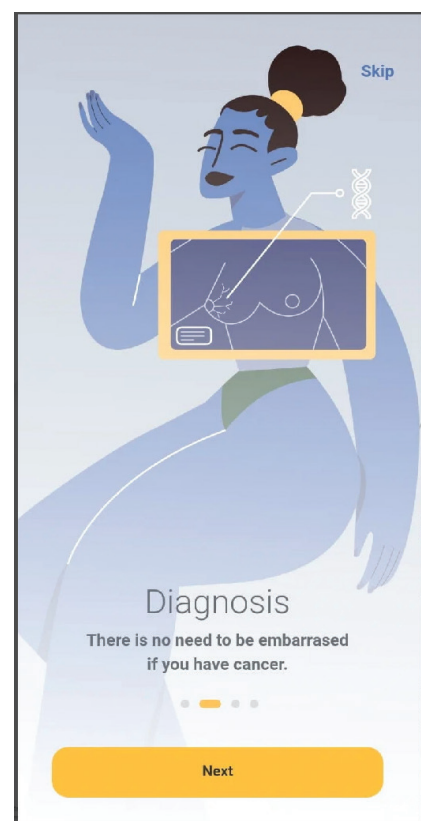
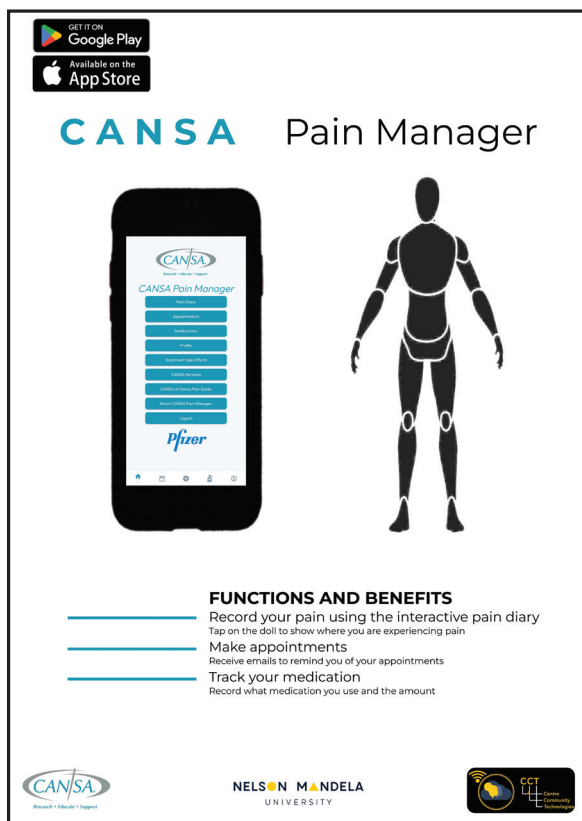
CANSA FREE2BEME

The CCT is also working with CANSA to develop a CANSA website for adolescents and young adults who have been diagnosed with cancer. Young people between 13 and 25 years old who are living with cancer have very different needs to those of older cancer patients and the new cancer programme, CANSA FREE2BEME, aims to address these needs.

Navigating the Big C

The CCT, Cipla and CANSA are collaborating on an online portal called Navigating the Big C to offer resources that provide cancer patients with the care and support they need to manage their condition.

Navigating the Big C caters for cancer patients and their loved ones, as well as those who want to support a friend or family member who has cancer, but may not always know what is needed. It offers information on the most common cancers, a support registry, cancer coping kit and training for death doulas.



Entity/Department: eNtsa

Project leader: Donnie Erasmus

Project team members: Akshay Lakhani, Elbert Liebenberg, Hubert van der Merwe, Keegan Kroutz

SDGs

13: Climate Action

14: Life Below Water



Donnie Erasmus

Marine glider to gather data underwater

A team from eNtsa has designed and built a remote-controlled underwater marine glider to provide a research platform able to reach a depth of 200m. The project, funded by merSETA, was initiated by the University's Advanced Mechatronic Technology Centre (AMTC).

The glider will gather information that can be used in the longer term to fight against ocean pollution.

Project leader Donnie Erasmus and team members Akshay Lakhani, Elbert Liebenberg, Hubert van der Merwe and Keegan Kroutz are keen that the vehicle should assist research entities to increase ocean monitoring activities, allowing them to influence legislation with scientific evidence.

The glider is a buoyancy-controlled autonomous underwater vehicle capable of carrying a payload of sensors that will enable researchers to measure variables such as conductivity (salinity), temperature and pressure (depth), all of which help to monitor the state of the ocean.

"If a requirement exists to carry a greater payload, the glider can be scaled up in a new build," says Erasmus.

The project supports the work of the South African International Maritime Institute (SAIMI) and the South African Institute for Aquatic Biodiversity (SAIAB).

Erasmus explains the rationale behind the research:

"South Africa has a coastline of approximately 3 000 km, flanked by the warm Mozambique Current on the eastern seaboard and the cold Benguela Current on the west. It is also one of the major trade lanes in the world, with many vessels travelling around the southern tip of Africa," he says.

"The oceans surrounding South Africa provide an exceptionally rich marine environment that supports a large fishing industry and this, coupled with the trade lane, means there is a heightened risk of marine pollution.

"Plastic and marine pollution in turn lead to increasing acidification of the ocean, and this needs to be measured."

It is vital, therefore, that parameters such as ocean temperature, pressure and salinity are monitored, enabling scientists to track changes and advocate for corrective legislation to be put in place, based on accurately researched data.



Above: The eNtsa marine glider in a static mount. Below: eNtsa engineering director Andrew Young, left, and eNtsa group specialist Hubert van der Merwe test the glider in the pool

Array of cross-disciplinary projects in service of society

Student members of the Advanced Engineering Design Group (AEDG) have been involved in diverse cross-disciplinary projects over the last year, and three of these are highlighted below.

Entity: Advanced Engineering Design Group, School of Engineering

Project leader: Clive Hands

Project team members: Student members of AEDG

SDGs

3: Good Health and Well-being

9: Industry, Innovation and Infrastructure

17: Partnerships for the Goals



Clive Hands

TPMS Heat Sink

An overlapping area of interest for the AEDG group is metal additive manufacturing (AM) incorporating lattice design together with heat exchange optimisation, which led to this honours project, carried out in collaboration with Rapid3D and Custom Works.

With modern-day central processing units (CPUs) demanding more efficient heat exchange to help cool the component, much more is demanded of heat sinks, which absorb excessive and unwanted heat.

Triply Periodic Minimal Surface (TPMS) lattices are unique to additive manufacturing, as ordinary subtractive and formative methods are not able to manufacture the complex design. Use-cases for these lattices are beginning to become more prevalent in parallel with AM evolution.

This project benchmarked thermal distribution between 15 different TPMS latticed heat sinks against a typical finned heat sink. TPMS type, wall thickness and cell size varied.

The resultant test array was kept relatively small due to the significant cost to 3D print these devices in metal.

Long-term collaborative partners, Rapid3D and Akhni3D, assisted with printing.

Selective Laser Melting (SLM) was the AM process used, in the powder bed fusion (PBF) process category. The TPMS lattices were designed to be self-supporting and were printed using PBF techniques on a state-of-the-art EOS M290 printer.

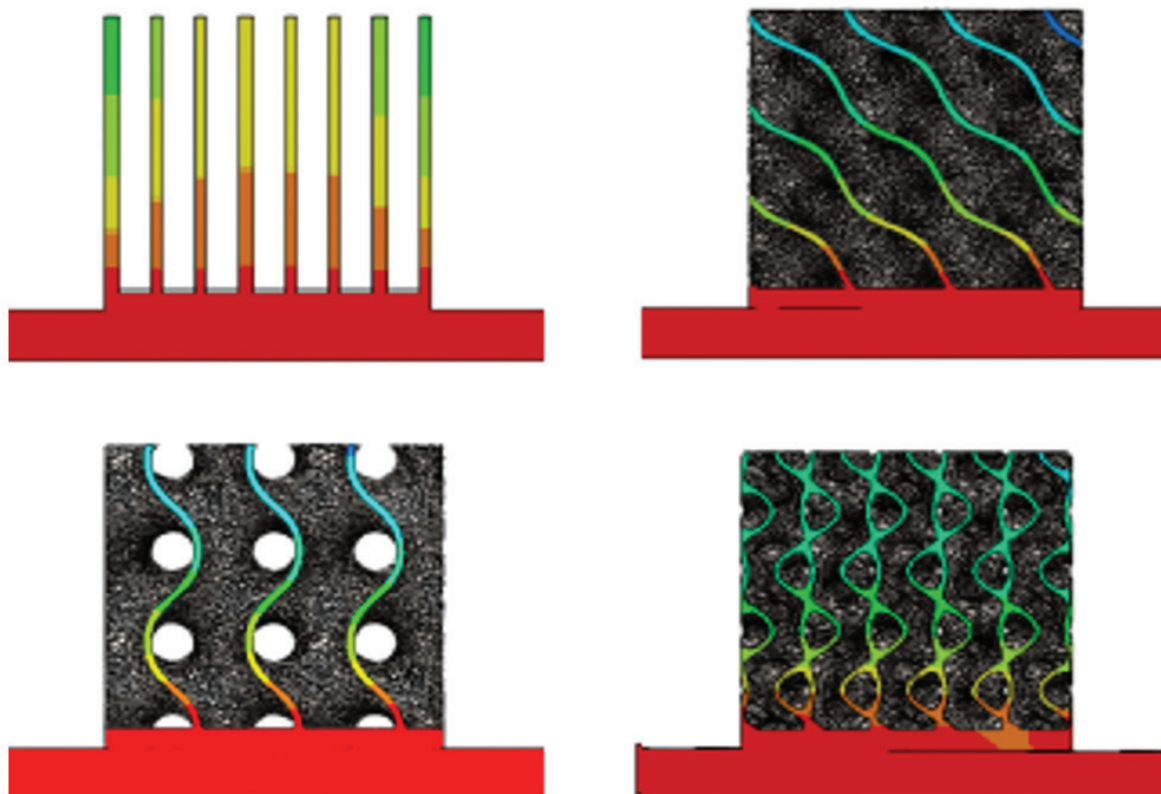
All testing and simulations were performed with a temperature source at a constant 100°C. The objective was to establish at what temperature the top surface of the heat sink reaches an equilibrium or plateau temperature.

A thermal imaging camera, supplied by Custom Works, captured thermal images of the heat sinks during the physical testing to confirm temperatures.

The recorded temperatures from the physical testing and the simulated data closely resembled each other. Therefore, it was possible to establish which of the TPMS lattice heat sink designs were the most efficient in terms of heat transfer.



Various 3D-printed TPMS heat sinks



Thermal cut plots of some of the lattice configurations tested

GT3 Dive Plane

The master's research project on the GT3 Dive Plane focuses on the front corner of the GT3 Lamborghini Huracan racing car to address its imbalance in aerodynamic downforce.

The collaboration of Custom Works and the Scuderia Scribante motor racing team was invaluable to the project, which follows on from 2021's Aero-Rake project and 2022's Aero-Profiling project based on Scuderia Scribante's Huracan.

The project intended to develop new canards, or dive planes, for the front corners to address the vehicle's understeer issues. This would be achieved by conducting computational fluid dynamics (CFD) simulations on a 3D-scanned model, and on-track pressure-testing and tuft-testing of Scuderia Scribante's race vehicle.

The CFD simulations were carried out using a cutting-edge Lattice Boltzmann (LBM) CFD solver in Altair UFX on a high-performance GPU cluster with 4 NVIDIA V100 GPUs.

This further established collaboration between the University and the Centre for High Performance Computing

(CHPC) in Cape Town. The centre's Lengau supercomputer cluster delivered extremely fast results compared to traditional solvers, enabling reasonably rapid iteration of simulation studies. Use of a wind-tunnel, however, was just not practical due to availability, expense and logistics. On-track testing will be done late in 2023.

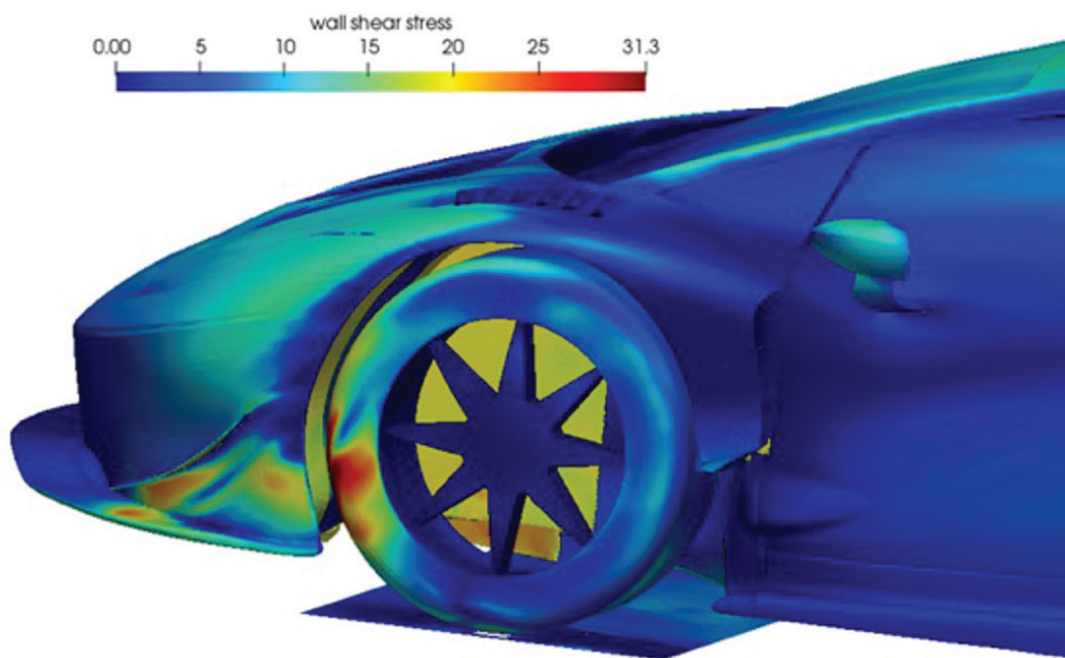
The simulations and testing were done on the base vehicle and repeated after improvements to the vehicle dive planes were made. This gives the researchers a twofold indication of whether the improvements were successful or not.

CFD has previously been considered the preserve of large commercial entities, as the resources and skills required were out of reach for smaller entities. As such, bridging the gap between global CFD expertise and local engineers is a crucial step towards the future of simulation driven engineering in South Africa.

The work in this research project has established AEDG's significant capability to address engineering problems that require CFD simulation. It also creates a learning platform for the future.



The existing Scuderia Scribante GT3 Lamborghini Huracan EVO showing its front dive-planes



An iso-surface output of velocity displaying vorticity and flow disturbance around the current full vehicle

Blood Alert

The Blood Alert project was devised in response to the call of doctors and specialists at Livingstone Hospital in Gqeberha.

Anaesthesiology staff team members, Dr Lorenzo Boretti and Dr Marné Page, highlighted the need for a simple device to autonomously monitor blood levels in a collection vessel under various surgery conditions.

They called for a device to alert medical staff when blood levels reach various predetermined markers. This is related to Patient Blood Management (PBM) where the idea is to optimise the patient's own blood and prevent the need for a blood transfusion.

The new Blood Alert system is an early detection or awareness device that contributes to the awareness of blood loss before it becomes significant. This means that the medical staff can intervene earlier and prevent further loss, possibly avoiding the need for a blood transfusion altogether.

The initial concept was to create a conformal band that could easily slip onto the collection vessels, fastened into place at predetermined positions depending on individual requirements. Furthermore, embedded sensors inside

the device should then detect the blood level and emit a warning alarm.

The design objectives were that the final device would:

- Have a minimal footprint
- Fit on to the vessels as unobtrusively as possibly
- Not interfere with the functioning of the vessels
- Be able to be operated by staff wearing surgical gloves.

This concept was the basis for the Blood Alert device.

Initially an Arduino-controlled option was considered, but it soon became apparent a custom passive printed circuit board (PCB) design was required.

The final PCB design was committed to printing on the in-house PCB printer and then tested further as a completed unit.

The initial prototype was then further optimised to work on the collection vessels with real blood, and handed over to the medical team.

The resultant Blood Alert devices are now being tested on-site to gauge where further updates in the design are necessary.



The Blood Alert device



Jode Fourie, left, and Brian Jack, right, hand over the two initial prototypes to Dr Lorenzo Boretti for testing

Motor industry collaboration with university benefits all

The guiding principles of the ISUZU Chair in Mechatronics, held by Prof Igor Gorlach, include facilitating cooperation between industry and academia, enhancing human capital development in the automotive sector and supporting academic research and innovation.

The Chair also provides academic support for junior students to mitigate any lack of knowledge in mathematics and science, a major factor contributing to the high student failure rate in engineering programmes. As a result of the Chair's tutoring programme, the number of graduates in engineering has been constantly improving.

Entity/Department: ISUZU Chair of Mechatronics,
Department of Mechatronics

Project leader: Professor Igor Gorlach

Project team members: Akhanya Ookweni,
third-year Mechatronics students

SDGs

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Professor Igor Gorlach

Test rig for new bakkie handles

As part of the new ISUZU vehicle launch in South Africa in 2022, a number of vehicle components were to be manufactured locally. Fourth-year student Akhanya Qokweni was assigned to work on a test rig for one of these components, a tailgate door handle for a bakkie, as his final-year mechatronics project in 2022.

He was provided with the basic geometric data and tailgate door handles for tests, but no actual computer-aided design

(CAD) data was given, which created some difficulties in designing and dimensioning the test rig.

Nevertheless, Qokweni successfully completed the project, designing a robust and innovative test that was manufactured at the University's engineering facilities. This test rig has now been successfully commissioned by ISUZU, and locally produced handles are accepted for new vehicles.



Akhanya Qokweni with the test rig

Material handling facilities

Certain car seats for ISUZU vehicles are manufactured locally and supplied using the just-in-time system (that is, according to the schedule of the assembly line for a particular day and time).

Delivery trucks bring car seats to the receiving area, where the seats are off-loaded and dispatched to the assembly line, primarily using manual labour.

Third-year Mechatronics students were assigned a mechanical design project to enhance the material handling system for car seats, using low-cost automation to improve ergonomics.

Working in groups, the students developed several alternatives, after which ISUZU engineers chose which they considered the best design.



The mechatronics team onsite at ISUZU plant in Struandale, Gqeberha

Material handling system for car cabins

ISUZU's bakkie assembly lines have overhead material supply systems that transfer car body panels and sub-assemblies between the assembly lines.

One such system is used for transferring car cabins from the cab robotic welding line to the final assembly line.

At the loading station, the material handling system operates fully automatically to lift car cabins.

However, at the off-loading station, a worker controls the hoist that lowers car cabins onto the conveyor, which creates a bottleneck in the process.

Third year students were assigned a project aimed at automating the material handling system for car cabins. In designing the station, their goal was to improve reliability and reduce downtime on the cab robotic welding line.

The primary role of engineering chairs, such as the ISUZU Chair in Mechatronics, is to facilitate human resource development by educating engineering students as well as professional engineers already practising in industry.

These three case studies show how a long-term university–industry collaboration provides mutual benefit to all partners.

These benefits include the development of problem-solving skills by completing industry-based engineering projects that combine theoretical with practical expertise, and fostering improved education, skills development and specialisation.

These university–industry relationships also improve competitiveness in relevant industries – such as the local automotive sector – and benefit the community at large.



Material handling system for car cabins

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